REVIEW OF LITERATURE

As mentioned elsewhere processed cheese is made by blending natural cheeses of different ages and sources, adding water, colouring agents and emulsifying salts and then heating and agitating until a homogenous mixture is produced. The final product has a consistency suitable for packing and can be stored at or near room temperature for a long period.

Over the past few decades, many aspects of the manufacture of processed cheese have been reviewed by many authers (Jackson and Wearmouth, 1959; Price and Bush, 1974 a and b; Shimp, 1985), and the same subject has seen discussed in recent text books (Meyer, 1973; Kosikowski, 1977; Thomas, 1977; Fox, 1987). In addition, Mann (1969, 1970, 1974, 1975, 1978 a and b, 1981, 1983 a and b, 1986 and 1987) has compiled several successively up dated international digest on processed cheese.

The quality of processed cheese is governed by many parameters such as raw materials, processing conditions, microbiological quality and rheological properties.

Factors Affecting The Manufacture of Processed Cheese:

Selection of raw materials:

A) Natural cheeses:

The most important step in the manufacture of processed cheese is the selection of natural cheeses. In some countries,

processed cheese is manufactured from only one very popular variety of cheese of different degrees of maturity, for example Cheddar cheese is normally used in the United Kingdom, while a mixture of Cheddar, Gruyers and Mozzarella used in USA and Canada, and Emmentaler in Western Europe (Fox, 1987). In Europe as well as in Egypt the use of Cheddar cheese as a basic raw material has become considerably popular (Gouda, 1980).

Templeton and Sommer (1930) concluded that blends of very young cheese showed excessive fat separation in processing, and a rubbery texture in the finished product, but using very old cheese gave weak body and grainy texture. The best product was from cheese between 4 to 7 months old.

The same authers in 1932 reported that the casein to fat ratio in the milk used for the original cheese has a marked effect upon the body of the processed cheese, the greater the proportion of fat the weaker the body.

Palmer and Sly (1943) reported that the maturity of the cheese used has an important bearing on the stability of the processed cheese emulsion. If the age cheese was old, texture was liable to be graing and oil separation could occur. On the other hand, very young cheese, generally gave a very stable emulsion. They explained that the protein of freshly made cheese consists chiefly of calcium paracaseinate,

while during the course of ripening, decomposed into uncombined paracasein and calcium salts. The paracasein is the further broken down into water soluble peptides, amino-acids and eventually amonia. Thus, the result of the ripening process was an increase in the concentration of calcium salts, accompanied by loss protective casein, both factors reduced the stability of processed cheese emulsion.

Wearmouth (1956) noticed that the main cheese used for processing in France and Switzerland are Gruyere, Emmental and Bxie and great care is taken to preserve their flavours. Carful control was exercised by routine treting, particularly on the fat content of the finsihed mix.

Arnott et al (1957) concluded that cheese less than 25 days of age would not improve the blend, and might harm the melting qualities of processed cheese. They added that the age of current cheese used in a blend is of more important than the average age of the blend.

Dimov and Mineva (1966) manufactured a special cheese from semi-skimed HTST pasteurized milk (1.5-2.0 % butter fat). Which involves the addition of rennet incubation with 0.1 % Str. lactis + L. casei culture, 0.2 % butter culture and 1 % culture of propionic acid bacteria and the addition of 0.02 % $CaCl_2$. The milk coagulates in 30-35 min, the curd is pressed, the cheese brine salted and after 2 week at 12-

14°C and 1 month at 18-22°C, it is stored at 10-12°C for further 6 wk. Mature cheese stored for 6 months at 5°C contained on an over age about 42 % moisture, 2 % salt, 4.9 % total N, 2.3 % soluble N, the last being higher in the cheese made from 2 % fat milk than in that from 1.5 % fat milk. The cheese had good consistency and a specific, pleasant and pronounced flavour. The ripe cheese was made into processed cheese without or with the addition of 20-50 white pickled cheese and kachkaval cheese or with up to 30 % fresh curd. All processed cheese had a good quality, the combination with 20 % curd giving in addition, considerable finencial savings.

A selection of the initial cheese for processing was discussed by Daclin (1968), he reported that a mixture from Emmental and Gruyere cheese containing 60-70 and 30-40 % respectively produces a good flavour in the final processed cheese.

Lauck (1972) claimed that a high proportion of solvage cheese can be used as a raw material for the manufacture of pasteurized processed cheese by incorporating up to 2.0 % by wt., of a surface active agent such as polyoxyethylene monostearate in the mix, in addition to the usual emulsifying salts.

Lukaszczyk (1975) in his review-type article deals with the type of cheese used for processing (mostly Cheddar cheese alone or mixed with Emmental, Gouda or Tilist cheese).

The degree of ripeness required for different types of processed cheese; compositional and physico-chemical properties of the cheese intended for processing, and microbiological characteristics of such cheeses (with particular refernce to hazards of anaerobic sporeformers).

Kosikowski (1977) mentioned that a large stock of mild to sharp natural cheese is required for successful processed cheese making. The key to successful selection, in addition to maintaining large stocks of natural cheese, are experienced selectors to properly identify flavour and body characteristics for blend uniformity. Blends of 55 percent young, 35 medium-aged and 10 percent aged natural stock give process cheese of optimum firmness and slicing qualities.

Processed cheese blends were compounded by Harvey (1978) using 75 % mild cheese and 25 % aged cheese (3-5 months) correlations were found between melting and work done on Ist bite, cohessiveness, springiness and chewiness. When 0.75 % $CaCl_2$ and 1 % lactic acid were added to the cheese blends during manufacture normal processed cheese could not be made. Lower levels of Ca increased melting spread significantly.

Park (1979) made various combination of 1, 3 and 5 months old Cheddar cheeses varying in flavour which were tested organoleptically. The best flavour was obtained in processed cheese from Cheddar cheese averaging 2.5 months old.

Zavagli (1979) used enzyme modified cheese (EMC) in a blend of 1 and 2 months old Cheddar to make processed American cheese slices.

Christensen and Russel (1981) blended aged blue cheese (<60 days) fresh blue cheese (10 days) in a ratio of 0.3-1.5 : 1; Cheddar cheese was added, if desired and then blended, together with emulsifying salts at 160-165°F for 2 min. The molten cheese was solidified and used as a processed blue by itself or as a salad dressing ingredients.

Shehata et al (1982) manufactured processed Ras cheese from four blends containing different quantities of natural Ras cheese and skimmilk powder. Processed cheese food of good quality could be obtained from a blend containing 60 % natural Ras cheese (50 % current + 50 % ripe), 18 % Bascee (9 % skimmilk powder), 2.5 % emulsifying salts and 17.5 % water, with 0.1 % sodium bisulphite and 0.03 % annato colour.

Hagrass et al (1984) stated that experimental processed cheese can be made from a blend of 20 % Ras cheese, 20 % imported cheese, 40 % dried skimmilk curd (Bascee), 3 % emulsifier, 7 % butter oil and water.

Magdoub et al (1984) suggested four blends containing different amounts of natural Ras cheese and skimmilk powder. Processed cheese spread with acceptable quality could be produced from a blend containing 44 % Ras cheese (60 %

current + 40 % medium ripened), 18 % Bascee (9 % non-fat dry milk), 7 % butter oil, 2.2 % emulsifier salts, 0.5 % gelatin and 28.3 % water.

Al-Dahhan (1985) made batches of ripened Cheddar cheese from cows', ewes or goats' milk; also, batches of Edam, Gouda and soft cheese were used for production of processed cheese. The cheeses were blended in different proportions. Processed cheeses were evaluated organoleptically after 1, 28 and 56 days. Organoleptic evaluation revealed that processed cheese made from goats' milk cheese had a weak flavour.

Lee and Ahn (1985) found that the modified Cheddar cheese by adding lipase before coagulation in order to accelerate lipolysis and ripening, was suitable for addition as a flavour enhancer for processed cheese.

Abd El Baky et al (1987) manufactured Ras cheese by the direct acidification and cheese ripening was accelerated by the addition of Formase and Piccantase Enzymes. Blends of processed cheese was achieved by using cheese ripened for 2, 4 and 6 weeks.

B) Concentrated milk (Ultrafiltrated milk):

Ultrafiltration is a process in which an emulsion such as milk moves continuously across a semipermeable membrane film and transfer most of its water, lactose, soluble salts

and non protein nitrogen to the outer surface of the membrane while, concentrate fat, proteins and insoluble salts along the inner (Glover, 1971; Glover et al, 1978; Beaton, 1979 and Glover, 1985).

In recent years the techniques of ultrafiltration have been applied in many areas of the dairy Industry such as soft cheese, hard cheese, yoghurt, milk powder, whey powder and cheese base.

Cheese base from ultrafiltrated milk was investigated by many researchers as a new techniques in the latest years in order to used in the processed cheese manufacture.

Kumar and Kosikowski (1977) suggested the manufacture of processed cheese from ultrafiltered skimmilk retentates combined with plastic cream. The problem of protein concentration was solved by the addition of freeze dried skimmilk retentates.

Covacevich and Kosikowski, (1978) reported further laboratory studies in which freeze dried UF skimmilk retentate was blended with water and plastic cream to make Mozzarella and Cheddar cheese. Such blend was not suitable for the manufacture of natural cheese but was suitable for the production of processed cheese at a rate of 50 % of the blend.

Ernstrom et al (1978 a) used unacidified and acidified (pH 5.7) whole standardized milk where they were subjected to

ultrafiltration, followed by diafiltration to obtain a retentates of suitable lactose, buffer capacity ratio, and finally concentrated ultrafiltration to 20 % of initial weight.

Ernstrom et al (1978 b) suggested the fermentation of retentates with Streptococcus lactis subsp lactis C_6 to remove all measurable lactose, evaporated under vacuum to remove excess moisture and salted to give a product with 33.7-39 moisture. yields (adjusted to 36 % moisture) after processing were approx. 12 kg/100 kg milk containing about 4 % fat and 12.4 % T.S. Blends contained 80 units of mature Cheddar cheese and 20 units of cheese base gave processed cheese of good flavours but the body was very firm.

Kumer (1979) concentrated raw skimmilk at 60°C by ultrafiltration and diafiltration. The retentate was mixed with plastic cream, pasteurized and homogenized.

The pre-cheese mix was blended with varying amounts of sharp Cheddar cheese, and the solid content was adjusted by the addition of freeze dried retentates. Salts, emulsifier and water were added to the mix which was heated to 75°C for 10 min. This product containing up to 40 % pre-cheese mix was judged better than commercial processed cheese. Food grade fungal protease and lipase preparations were incorporated into the pre-cheese mix which was then stored at 45°C for 24 hr to accelerate protein and fat hydrolysis in

the product. Enzyme treated retentate was used up to 60 % substitution of natural cheese and gave a product which had improved flavour and acceptability. The same enzymes were added to Cheddar cheese slurries made from fresh salted curds for the production of medium sharp Cheddar cheese with 3 months maturation at 10°C. Microbial enzyme treated Cheddar cheese developed higher levels of soluble protein and free volatile fatty acids, and displayed better flavour and acceptability than the control cheeses.

Sood and Kosikowski, (1979) manufactured processed cheese by using 0, 20, 40, 60 or 80 % addition of "pre-cheese" mixed with natural cheese. The "pre-cheese" was a mixture of raw UF skimmilk retentate, homogenized with 70 % fat plastic cream. Replacement of up to 40 % natural cheese with "pre-cheese" product gave a more acceptable processed cheese than the control (i.e processed cheese made from natural cheeses). Incorporation of 80 % "pre-cheese" in the blend gave a product with hard and long-grained texture which was unacceptable to the tase panel. Melting index of the processed cheese decreased from 79 to 14.3 % as the protortion of "pre-cheece" was increased from 0 to 80 %. Addition of 60 % pre-cheese mix, incubated with 0.01 % fungal proteinase and 0.00005 % lipase at 45°C for 24 hr before mixing with Cheddar cheese, gave a processed cheese with more flavour than that made with 40 % untreated "pre-cheese". Addition of different types of retentates

(direct ultrafiltration with or without fermentation and double diafiltration and fermentation) was also studied. Double diafiltration gave processed cheese with poor melting qualities.

Chambon et al (1980) prepared a pre-cheese from a protein concentrate obtained by ultrafiltration (i.e. 5-25 % T.S.) which was mixed with cream, butter or butter oil (or optionally vegetable fats) and salt. The mixture was homogenized and sterillized at 100-150°C for 5-60 s, and then fermented using thermophilic starters, e.g Streptococcus ralivarus subsp. thermophilus, Lactobacillus helveticus and propionic acid bacteria. After fermentation, the product had a slight cooked flavour which could be used in the production of processed cheese as well as in cooking. By using other starter organisms, different aromas may be obtained.

Ernstrom et al (1980) developed a method for the production of cheese base in which whole milk was pasteurized, cooled, acidified to pH 5.7 (or not acidified), ultrafiltrated to 40 % of its original weight, diafiltrated at constant volume. The unacidified concentrate was fermented to remove the residual lactose. The excess moisture was removed in a scraped surface vacuum evaporator to produce cheese-base (CB). The CB can be used as a potential replacement for the young

natural cheese component of processed cheese blends. It had the same pH and gross composition as Cheddar cheese, a good flavour and stability but lacked normal cheese body and texture characteristics. The process of cheese base gave a yield, 16 to 18 % greater than could be expected from conventional cheese making processes. Ultrafiltration of unacidified milk offered process advantages compared with acidified milk to pH 5.7, and the products were similar in quality. A blends consisting of 80 % CB and 20 % matured Cheddar cheese, produced good flavoured process cheese and process cheese food. The body of the process was excessively firm, but that of the process cheese food was satisfactory.

Madsen and Bjerre (1981) prepared a cheese-base compared of a product which is made by means of ultrafiltration and which, in chemical respect, is identical with Cheddar cheese. They used this cheese-base in processed cheese instead of level cheese. The production technique for cheese-base uses ultrafiltration, ripening to pH 5.2 and evaporation to the required dry matter content (60 percent). It is calculated that the savings in milk utilization for cheese-base amounts to 16.2 percent, as compared to the usual milk volumes used for preparing Cheddar cheese for making processed cheese.

Wargel et al (1981) stated process for the preparation of processed type cheese from basic dairy ingredients rather

than natural cheese. This involved the following stages of processing. Milk was ultrafiltrated to produce concentrate 50 % moisture then diafiltrated followed by further concentration. The prepared protein concentrate was partially hydrolysed (5-50 %) and mixed with 20 % fermented cream and blended for minutes to obtain a premix. Cheese starter culture was added to the premix and pH allowed to drop to 4.9-5.3; and finally emulsifying salt was added and heated to manufacture a processed cheese product.

Ramanushas et al (1982) suggested the following approach to accelerate ripening of cheese base UF skimmilk concentrate (i.e 15 % protein) was pasteurized and thermal evaporated under partial vacuum to produce concentrate of 45 % total solids. The concentrate then fermented with 1.5 % starter culture (Str. lactis and Str. thermophilus) at 35°C until pH reaches 5.5. Cream was added to obtain a mix of 60 % moisture and 40 % fat in dry matter (FDM). 3 % emulsifying salt consisting of mono-sodium and disodium phophate was added, followed by 1.5 % cooking salt, 0.06 % $CaCl_2$ and enough rennet to coagulate the milk in 25 min, the product was filled into 50-200 kg containers, and mature for 15 days at 18°C. Such cheese base was used in the production of processed cheese.

Rubin and Bjerre (1983) reported the details about the production of cheese base for replacement of natural cheese

during the manufacture of processed cheese. Pasteurized whole milk (3.5 % fat) was ultrafiltrated and diafiltrated at 50°C to a retentate with 40 % T.S and 1.17 % lactose. The retentate was HTST pasteurized, cooled to 30°C, 1 % starter was added. After 2 hr standing the product was evaporated at 42°C under partial vacuum to 62 % T.S, packaged and kept at 25°C for 26 hr by which time the pH attains 5.2 and did not fall subsequently any further. The packaging container may be adventgeously a plastic bag closed with vacuum application. The base may be used at 80:20 ratio with ripe cheese in the production of processed cheese.

The effect of acidity in milk during the production of cheese base has been studied by Anis and Ernstrom (1984). Whole milk (3.5 % fat) was adjusted to 4°C and pH 6.6, 6.4, 6.2, 6.0 and 5.8 with concentrated HCl. After equilibration and readjustment of pH, the milk samples were warmed to 54°C and concentrated by UF to 40 % of original milk weight. Diafiltration was carried out to different constant volumes, for example, 38.5, 46.7, 54.3, 62.0 and 70.0 % of the original milk weight for the samples whose pH were 6.6, 6.4, 6.2, 6.0 and 5.8 respectively. All samples were reduced to 20 % of original volume, then inoculated with lactic starter culture and fermented to pH 5.1-5.2. The fermented retentates were evaporated under vacuum to 36-38 % moisture. Samples were made into process cheese food containing 43 % moisture,

4.5 % salt in moisture and 2.5 % emulsifying salt. Melting properties of the cheese food increased with decreasing pH of the milk prior to ultrafiltration. This corresponded with calcium concentrations in the final retentate which decreased from 47 % of original milk calcium at pH 6.6 to 30.61 at pH 5.8. The drop in pH value also reduced the permeation rate during ultrafiltration. Treatment of the ultrafiltrated milk with rennet, destroyed the meltability of the processed cheese food. Melting properties of cheese food processed with sodium citrate and sodium aluminum phosphate were superior to the cheese food processed with disodium phosphate, tetrasodium pyrophosphate and trisodium phosphate.

Gronfor (1985) reported that a processed cheese-like product was made from 25 Ib skimmilk, 256 Ib whole milk retentate (40 % T.S), 24.1 Ib of two modified corn starch products, 256 Ib shredded Cheddar cheese, salt preservatives and colouring matter. The blend was heated in a swept-surface heat exchanger at 81°C for 3-5 min. Whey protein concentrate may also be used in the blend.

Gouda and El-Shibiny (1987) reported that 40 and 60 % percent of acidified skimmilk powder (Bascee) used in the blend of processed cheese spread were replaced with ultrafiltrated skimmilk retentate (24 % T.S). Also Bascee was completly replaced in the processed cheese blend with curd obtained from rennet coagulation of the skimmilk retentate.

The organoleptic properties of the cheese were assessed. Forty percent replacement of skimmilk powder with retentate gave processed cheese spreads of acceptable properties and composition.

pH values:

The uniformity and quality of processed cheese depends on pH control. This factor is as important as the selection of natural cheese. The adjustment of pH is achieved by blending the correct type of emulsifying salts.

Templeton and Sommer (1930) found that good results were obtained with cheese ranging from pH 5.8 to 6.2. This would indicate that this factor can be adequately controlled by exercising discrimination in blending.

Templeton and Sommer (1932) concluded that the best body was achieved when the pH level ranged between 5.6 to 6.1. However, little difference was observed in the texture of processed cheese when the pH level ranged 5.7 to 6.3.

Palmer and Sly (1943) reported that processed cheese was more susceptible to oil separation when pH value was either abnormally high (5.8-6.0) or abnormally low i.e blew 5.4.

Wearmouth (1954) found out that most processed cheeses of the standard type and publicly available had pH values

ranging from 5.9 to 6.6. However, samples of cheese with values outside such range, either faulty, abnormal or were of very special blends and composition.

Faivre (1955) cleared a certain relationship that existed between the temperature of processing and acidity. The result of these two factors was a constant value. The acidity decreases with increasing the temperature. A product of good quality, for example, heated to 90°C and having pH of 5.8, the end product would be lower in pH.

Meyer (1973) suggested that the pH range of processed cheese was relatively limited and lies essentially between pH 5.4 to 6.2. A useful product with the correct consistency and structure can only be produced within this small range. An increase in pH value would lead to a better peptisation of the casein, but the body of the cheese would be less viscous. On the other hand, a decrease in the pH value would lead to a thickening and solidifying of the cheese structure and causes coagulation. The pH of a good block processed cheese could range between 5.4 to 5.7; where as cheese spreads might have a pH value between 5.7 to 5.9. The Danish processed cheeses have a pH value between 6.0 to 6.3.

Kosikowski (1977) recommended the following pH range for different processed products:

a) 5.6-5.8 for processed cheese.

b) 5.4-5.6 for processed cheese foods.

c) <5.2 for processed cheese spread.

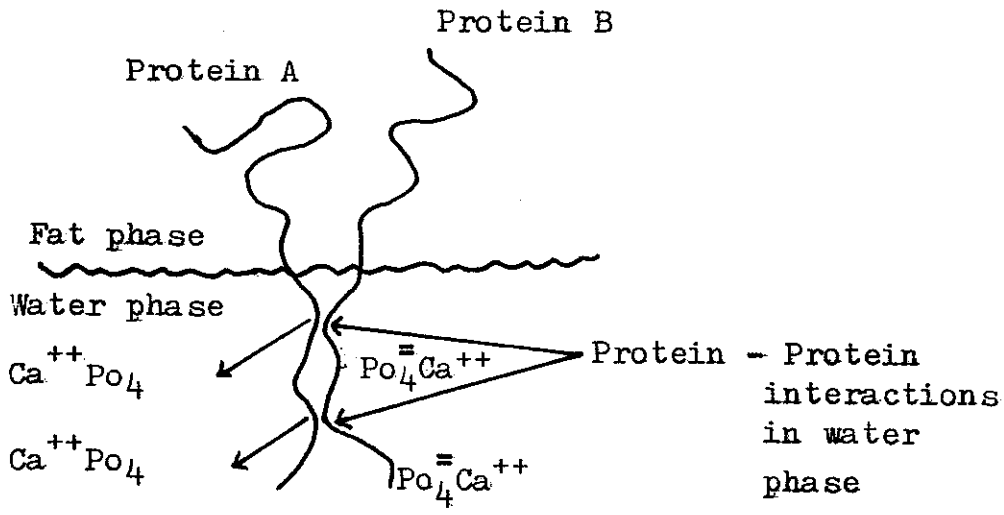
Thomas (1977) recommended that pH in blok processed cheese should be between 5.4-5.7, but the pH in processed cheese spread from 5.8 to 6.0.

Emulsifying salts:

Emulsifying agents are used to prevent the separation of cheese into its three main constituents (fat, protein and water) during processing and also to improve the body and texture of the finished product. The salts should be sufficiently soluble to ensure that crystallization does not occur in the blend, and they are usually used at the rate of 2-4 %. The commonly salts are sodium citrate, sodium aluminum phosphate, monosodium phosphate, disodium phosphate, disodium phosphate, tetrasodium pyrophosphate, sodium tripolyphosphate, sodium hexametaphosphate and insoluble metaphosphate.

Emulsifying salts tend to undergo some physico-chemical changes due to the influence of heat, agitation and certain combination within the cheese mass. This was due to a partial saponification between of the salt and the fatty acids however, the anion, which had acted as a solvent for casein, tended to combine with this portion of the cheese in such a manner forming a film of casein sourrounding each

fat globule to prevent the escape from the cheese mass (Habicht, 1934).



This figure clears that the casein protein contains calcium phosphate groups in one end region which carries essentially all of the protein charge. The other end is organic and nonpolar in nature. The phosphate end is water-soluble while the organic end is fat-soluble, this what gives these proteins emulsifying properties. Emulsifying salts remove the calcium by exchanging it for sodium or else bind to it in place and mask its effects therefore, the emulsifying power of the proteins is enhanced. The most common by used emulsifying salts are those which bind weakly to calcium. These give the weak emulsification that produces the highly soft and easily method cheeses.

Palmer and Sly (1943) discussed the theory that the melting salt was probably the most important single factor in the production of satisfactory emulsion. They claimed that various compounds which had been recommended as cheese-melting salts could not discussed here, but the function of the melting salt appeared to have two effects (a) to act as a solvent for the cheese protein and (b) by stabilising the emulsion as a result of oil/water interface adsorption. Two and four percent of melting salt per weight of cheese should be sufficient. Any considerable advance on this concentration leads to no improvement in the emulsion, and may have an adverse effect by bringing about partial dehydration of the protein.

In an attempt to understand the role of emulsifiers in the processing of cheese, a series of inorganic and organic compounds had been studied (Holtorff et al, 1951). Evaluation was made in terms of changes in water-soluble nitrogen, fat leakage, compressability knitability and flavour of the finished product. Data was gives for combinations of certain compounds and for concentrations up to 3 %. Satisfactory emulsifiers consisted of polyvalent anions, from alkaline solutions which were precipitated or sequestered. Although all the comounds satisfy these criteria, were not good emulsifiers. However, conventional fat and water emulsifiers such as Tweans and Spans, fail in their application and

acted as de emulsifiers in some instances. Other materials, though producing a satisfactory emulsion at the time of use, showed degeneration of knit and body upon storage.

Geffers et al (1973) studied different emulsifying salts used to prepare processed cheese to swell the protein and to distribute the water and the fat evenly to obtain good spreading capacity and good cutting strength. These comprise salts of phosphonomalic acid or its derivatives. These additive, were used in the form of an aqueous from that were stable at storage.

Kairyukshten et al (1973 a) evaluated the effect of various emulsifying salts on the physico-chemical properties of processed Dutch cheese. The salts compared were orthophosphate, pyrophosphate, triphosphate, citrate and Graham salt had pH values of 8.89, 6.61, 9.31, 8.16 and 5.49 respectively in 3 % (w/w) solutions. The processed cheese contained an increase level of the higher-molecular soluble protein, and it was observed an improvement in the water-binding capacity and plasticity. These effect were most marked with use of the texture, flavour and colour of processed Cheddar cheese, that a 1:2 mixture of disodium phosphate and trisodium phosphate added at the level was the most suitable.

In recent years several research workers have carried out experiments to determine exactly the quantity of emulsifying salt required and formulae have been set up help

operating personnel to ascertain, use necessary dose of emulsifying salt in certain circumstances. So, "Joha Basic emulsifying" salts have been used in the processed cheese industry with great success for thirty-five years (Meyer, 1973). At the moment, there are more than twenty different Joha emulsifying salts, available for different types of processed cheese.

Kosikowski (1977) stated that the function of emulsifying salts in process cheese were (a) to regulate pH for optimum body, texture and control of spoilage (b) to dissolve protein for integration of fat, protein and water into a uniform smooth mass and (c) to reduce the size of the paracasein through peptidization and create desired short texture.

Thomas (1977) reported that emulsifying agents processed a distinct affinity with calcium and combined with calcium ions by either precipitation or sequestration. Sequestration was the process by which insoluble paracasein was changed into a relatively soluble form of casein. Thus, the cheese had changed from its flocculated, coagulated, semisolid state until it had reached its limit of solubility which depended not only on the natural cheese used but on the emulsifying salt employed.

Fox (1987) reported that the essential role of the emulsifying agents in the manufacture of processed cheese

is to supplement the emulsifying capability of cheese proteins which was accomplished by:

- removing calcium from the protein system;
- peptizing, solubilizing and dispersing the proteins;
- hydrating and swelling the proteins;
- emulsifying the fat and stabilizing the emulsion;
- controlling pH and stabilizing;

and forming an appropriate structure after cooling.

Heating process:

Heat and agitation are essential for creating the right conditions for emulsification of cheese. The physico-chemical process changing the coaresly dispersed casein-gel into a homogeneous sol is best accomplished by heat, preferably at temperatures between 70 and 75°C for at least 3-4 min (Meyer, 1973; Kosikowski, 1977; Thomas, 1977 and Harvey, 1978). In addition to the action of the heat in the actual peptization of the casein, it also exerts an appreceable influence on the structure of the processed cheese by working together with the unchemical and chemical enviroment so as to support the natural tendency of the casein to absorb water and swell. This process, accompanied by a shortening of the structure and afirming up of the body, which is known as creaming (Meyer, 1973).

However higher temperatures of 80 to 85°C for 4-5 min is necessary to prevent fermentation during storage of

processed cheese and to ensure a long keeping quality (Kosikowski, 1977; Gouda, 1980 and Fox, 1987).

Packaging, cooling and storage:

Templeton and Sommer (1930) concluded that the keeping quality of processed cheese was dependent upon the heat treatment, the reaction between protein and emulsifying salts and to some extent upon the storage temperature. Discoloration of the tin foil could be due to the use of phosphate base emulsifying salts or to the use of alkali giving a reaction above pH 6.3.

Palmer and Sly (1943) established that on standing, the potential between the charged particles of an emulsion and their medium falls slowly, so that any tendency to oil separation is increased if the processed cheese is allowed to stand for any length of time before being fed to the packing machiness. The agitation to which the cheese is subjected in the hoppers of the packing machines must also be taken into account. These facts go far explain why oil may separate from processed cheese in the packing operation sometime after it has been cooked.

Sone et al (1970) reported that at the early stage of storage, the slow cooled cheeses are generally harder than the rapid cooled ones. However, the hard mass of rapid cooled cheese increases gradually with storage time and

approaches the hardness of slow-cooled cheese after 4 months. By contrast the hardness of slow-cooled cheese remains virtually unchanges during storage.

Fox (1987) mentained that processed cheese is usually packed and wrapped in lacquered foil, in cardboard or plastic cartons and occasionally in glass jars. A relatively new development is the continuous slicing and packaging of the cheese slices, suitable for sandwiches. Slices may also be obtained by mechanically slicing of rectangular processed blocks. A general rule for cooling processed cheese; it should be as fast as possible for processed cheese spreads and relatively slow for processed cheese blocks (rapid cooling softens the product). However, slow cooling can intensify Mailard reactions and promote the growth of sporeforming bacteria. The final product should be stored at temperatures blew 10°C, although such low temperatures may induce crystal formation.

Physical properties of processed cheese:

A relation between pH and melting quality reported by Eckberg and Mykleby (1949). A low pH cheese had the tendency towards better melting quality, and high pH cheese had poor melting quality. Generally high acid cheese was indicative of faster protein hydrolysis than low acid cheese, with the degree of protein breakdown being related to melting quality.

Arnott et al (1957) investigated the relationship of fat, moisture, pH and free tyrosine contents to the melting quality of Cheddar and processed cheese. No relationship was found for the first three factors, but free tyrosine related to good melting quality in processed cheese.

Olsen and Price (1959(observed that by varying the moisture content of processed cheese spreads at a constant ratio of SNF : Fat, caused significant changes in the firmness of the product. The firmness was measured by using the penetrometer. However, variations in the fat content and maintaining a constant ratio of SNF : Moisture did not affect the cheese firmness. Replacement of cheese SNF by lactose or dried skimmilk but maintaining a constant ratio of fat : moisture caused a decrease in the spread firmness of cheese. A definite relationship was established between cheese moisture, SNF and penetrometer values.

Olson and Price (1961) found that effects of variations in composition on the firmness of pasteurized cheese spreads made with "Dariwald" cheese could be determined by (1) modifying moisture and fat contents of a base formula and (2) by substituting nonfat dry milk (NDM), lactose, or dried whey for part of the solids-not fat supplied by cheese (CSNF). Firmness of spreads varied inversely with moisture, where the proportion of solids-not fat to fat was held constant. Firmness was not affected by changes in fat when

the ratio of moisture to solid-not fat was not altered. Use of increased amounts of lactose and dried whey decreased the firmness of spreads. Addition of NDM was less effective in decreasing firmness. Firmness increased when the proportion of moisture to cheese solid-not fat (H_2O/CSNF) was decreased, this relationship notably regular for all modification. Some samples containing added lactose and NDM increased markedly in firmness and acidity during 90 days of storage at 90°F. Spreads without added NDM or lactose did not increase in firmness during storage for 90 days at 90°F regardless the levels of moisture or fat.

Vakaleris et al (1962) noted, that in spite of the general similarcity satisfactory penetrometer and melting values occurred only in spreads made from normal cheese and then only when soluble nitrogen had developed to approximately 12 to 15 % total nitrogen and formol nitrogen to 2 to 3 % of total nitrogen. Changes in pH during making and curing were more significant than proteolysis in determining rheological properties of the cheese spreads.

Kapats (1969) measured the hardness by a Hoppler consistometer after the processed cheeses had been stored for 24 hr at room tempertaure after manufactured with final moisture contents of 42, 46 or 50 % and it was observed that the hardness increased as moisture content increased.

Kapats (1970) studied the consistency of processed cheese made from kachkaval cheese alone or mixed (4 : 1) with white soft cheese by using a Hoppler consistometer, and concluded that best texture was obtained when using sodium citrate and initial moisture content of 50 %, however, the type of cheese had no influence on such rheological property.

Thomas (1970) found a correlation ($P < 0.01$) between overall quality, and firmness, crumbiliness, slicing properties and elasticity, but not with stickiness. The latter property was correlated positively with firmness but negatively with crumbliness. Correlations were also found between elasticity, crumbliness and slicing properties.

Thomas et al (1970 a) reported that four instruments were developed and a commercial penetrometer was modified to measure the physical properties of processed cheese. Three major trials were conducted covering the range of each of the basic properties under study, namely firmness, crumbliness and stickiness. The relationship between the subjective and objective ratings of 1400 samples of processed cheese were discussed. High correlations were obtained between subjective and objective gradings for firmness and for crumbliness, indicating that at least these two properties of processed cheese could be measured objectively. The two instruments,

designed to measure stickiness and sliceability failed to give useful results.

Thomas et al (1970 b) developed an instrument to measure both elasticity and firmness in processed cheese and the performance of the instrument had been estimated. The correlation between the greader's scores and the instrument readings for 188 samples was found to be: firmness = 0.805 elasticity = 0.521 or 0.518.

Fukui et al (1972) observed that the texture of processed cheese was best assessed by hardness also by adhesiveness. With an increase in moisture content of processed cheese from 40 to 50 %, hardness declined rapidly and approx. linearly white, adhesivenes increased. Trends were more marked at $<$ 44 moisture content. Hardness decreased with increase in pH from 5.3 to 6.2 and with increase in degree of ripening. Measurements of variations in cohesiveness and springiness were unsuitable for assessing cheese texture.

Kairyukshtene et al (1973 b) studied the effect of various factors on the consistency of processed cheese under laboratory conditions, employing a temperature of 85°C for the processing operation. The moisture content of the cheese exerted a significant effect on the consistency by varying it between 41.7 and 49.7 % whilst maintaining the fat in DM

at 45 % it was possible to produce cheese of hard fine or soft consistency. Increasing the fat content in DM from 0 to about 50 % gave cheese consistency ranging from hard and rubbery to soft and fine. In comparison using 5 different emulsifying salts, sodium citrate gave cheese which was awarded the highest scores for consistency and flavours.

Kairyukshtene et al (1977) used the labor 365 conical plastometer of Hungarian manufacture for consistency measurements of "Novyi" processed cheese with 40 % fat using 2 ribbed cones of 30 vertex angle weighing 23.0 and 5.88 g and 2 other cones of 45° vertex angle weighing 70.15 and 8.62 g. Penetration data of the different cones are graphically presented, relationships between cheese moisture content and penetration and sheartress being shown and effects of temperature being also considered.

Chen et al (1979) measured six textural characteristics, hardness, cohesiveness, adhesiveness, elasticity, gumminess and chewiness by an "Instron Testing Machine" for 11 cheese samples ranging from parmesan to processed cheese. These objective textural measurements correlated closely with a panel's measurements. The textural measures were also in close correlation with composition and pH of cheese samples. An approach was demonstrated for evaluation of the multidimensional system. Chewiness, which only can be calculated

in the traditional method may be measured directly with the technique.

Rayan et al (1980 a) prepared pasteurized processed cheese by heating Cheddar cheese to 82°C for up to 40 min in the presence of 2.5 % (i) sodium citrate, (ii) disodium phosphate (iii) tetrasodium pyrophosphate or (iv) sodium aluminium phosphate. The cheese was examined by scanning and transmission electron microscopy and for rheological properties. As cooking time increased, the cheese became firmer, more elastic, tougher, had a lower meltability and a firmer and more uniform protein net work was formed. Undissolved (i) and (ii) crystals were detected in cheese heated for 40 min.

The same authers (Rayan et al, 1980 b) sampled the processed cheese for microstructural and rheological examination after 0, 5, 10, 20 and 40 min at 82°C. Even though each emulsifying salt affected the phsical properties of the processed cheese differently, the cheese generally became firmer, more elastic and less meltable as cooking time increased from 0 to 40 min. These changes were accompanied by a decrease in the dimension of fat masses and an increase in the degree of emulsification as evidenced by scanning electron microscopy and transmission electron microscopy. Sodium citrate and tetrasodium pyrophosphate

crystals remained undissolved in the cheese after 40 min in the cooker, while, sodium aluminum phosphate crystals were undissolved after 10 min.

Harvey et al (1982) reported that meltability and textural characteristics were evaluated in 48 batches of processed Cheddar cheese prepared in pilot plant equipment. Correlation between melting spread at 139°C and cohesiveness at 21°C was positive and large. Prolongation of cooking up to 15 min at 74°C lowered meltability and cohesiveness. Within the range of weighted average ages of cheese (3 to 5.8 months) no relation between melting spread or cohesiveness and age was consistent.

Gupta et al (1984) discussed commercial processed cheese, cheese foods, and cheese spreads were characterized for meltability, sliceability, composition, rheological properties (Instron), and descriptive sensory attributes. Samples varied within each grouping. Seventeen emulsifier salts were evaluated for performance experimental processed cheese by the same criteria for the commercial samples. Tripotassium citrate, dipotassium phosphate and tetra-potassium pyrophosphate, each contributed properties to processed cheese that should be useful in the development of blends of emulsifier salts reduced sodium processed cheese possessing a wide range of physical properties.

Microbiological Quality of Processed Cheese:

Meyer and McIntire (1953) reported that processed cheese products manufactured by ordinary commercial procedures contain a microbiological flora which may activated during prolonged military storage and handling under advance conditions. Destruction of microorganisms, including spores, in cheese products would be a desirable means of improving the keeping quality of the product.

Iipinska and Strzalkowsha (1958) manufactured processed cheese from natural cheese that developed butyric acid fermentation with or without the addition of nisin (British and Polish origin) and stored at room temperature. The percentage of processed cheese showing butyric acid fermentation was considerably higher in the control than the experimental lots (100 % vs. 45 % after 3 months).

Jaynes et al (1960) determined the effect of pH and brine concentration on the thermal process required to destory and to attenuate spores of PA (putrefactive anaerobe) of a known heat resistance in a cheese spread. A single lot of cheese spread base was used for all tests. Heating tests were conducted with thermal death time cans (size 208 x 006) heated in miniature retorts. The results of this study revealed that the brine concentration had no effect on the destruction of the spores by heat, but that a decrease in pH resulted in decreased heat resistence of the spores. The heat attenuation tests indicated that both an increase in brine concentration

and a decrease in pH reduced the amount of heat required to inhibit the growth of PA3679.

The same authers (1961 a) reported that gas production by PA (Putrefactive anaerobe) 3679 in a processed ccheese spread containing 8.5 % skimmilk powder and packaged in TDT (Thermal death time) cans incubated at 37°C, pH levels of 5.2 to 7.0 and brine concentrations of 2.0 to 8.4 %. Most of the expansion attributable to gas production in the TDT cans occurred during the first 20 days and no measurable gas production developed after 60 days. As the pH decreased from 7.0 to 6.0, the lag time for gas production increased and gas production was completely inhibited at pH 5.6 below. As the brine concentration increased, the lag time for gas production increased, and there was a decrease in the rate, total amount, and duration of gas production. Gas production was completely inhibited at a brine concentration of 7.6 % or more.

Jaynes et al (1961 b) studied some factors affecting the heating and cooling lags of processed cheese in thermal death time cans. They found that the lag correction factor, the time that must be subtracted from the gross heating time to gave the net time at heating medium temperature varies with the fill-weight and the position of the can for conduction heating of cheese spreads. Results of this study indicte that: (a) The lag correction factor increases with increasing in the fill weight. (b) The lag correction factor was larger when the can was heated in the flat position as compared to the edge position.

Jaynes et al (1961 c) found that tests conducted on a processed cheese spread inoculated with PA (Putrefactive anaerobic) 3679 and packaged in TDT (thermal death time) cans indicated that only a small amount of heat would prevent gas production as measured by can expansion, whereas a considerably greater amount of heat would kill the spores. The average D_{250} values of PA3679 in cheese spread at pH 5.50, 6.25 and 7.00 were 0.67, 1.01, and 1.21 min, respectively, with a Z value of 18°F. A surviving spore population in the range of 10^3 to 10^5 per g is necessary for gas production by this organism in the processed cheese spread tested. As processing temperature increased, the calculated number of spores necessary to initiate gas production decreased. The thermal resistance of a spore suspension of PA3679 in neutral phosphate buffer was equivalent to a D_{250} value of 0.98 with a Z value of 17.5°F, as measured with the thermoresistometer technique and subsequent subculturing in liver infusion broth.

Marenzi and Salvadori (1969) determined the microflora of Italian processed cheese, (with added nisin) obtained from 4 different factors without incubation or after incubation for 18 or 27 days at 25°C or 25 days at 37°C. They reported no moulds, anaerobic spores (butyric acid or sulphite-reducing) or coliforms were found. Six samples had normal organoleptic properties and 7 had various organoleptic defects ranging from wheying off to putrid aroma. A total of 100 Bacillus strains were isolated from cheeses. No correlation could be established between type of cheese defect and composition of the microflora.

Pulay (1969) found that the likelihood of butyric acid blowing occurring in processed cheese increased with increasing number of clostridia in the natural cheese. However, processed cheese manufactured from (i) natural cheese which had been fermented by clostridia was as good as or better than that produced from (ii) cheese which had just blown even though (i) contained 100-10000 X more clostridial spores than (ii); this is attributed to the formation, in (i), of compounds which inhibit clostridia and approx. the same time as butyric acid fermentation takes place. Butyric, valeric and caproic acids had an inhibitory effect, this effect increasing with mol. wet. of the acid. Carbohydrates and flavouring compounds (pritamine, paprika, cucumber, tomato) used in the production of various types of processed cheese, stimulated the growth of clostridia; fructose pritamin, red papnka salad in vinegar and tomato puree had the greated effect. By reducing the equilibrium RH from 97.5-98 % to 95-95.25 % and the moisture content correspondingly from 63 to 44.6 %. The keeping quality of the processed cheese was increased from 4 to $>$ 60 days and deterioration rate decreased from 100 to 0 %.

Gudkov et al (1973 a) found that samples of Rossirkiy cheese were melted at 95°C in 3 kg vessels in the presence of sodium triphosphate and tetrasodium phosphate, 8000 spores of (i) Cl. tyrobutyricum 1755 or 1300 spores and of (ii) Cl. sporogenes were added/g cheese, each with 150 units nisin/g or without nisin. The mixture was stirred for 10 min, distributed at 100 g into 2.8 x 28.6 mm cans, the cans were

sealed, heated in an autoclave to 100, 105, 110, or 115°C at 1°C/min temperature increase, and held at there temperature for 5, 10, 15, 20, or 30 min. Spore surival was then determined in 1 can, and the remainder were stored at 30°C for 3 months, belowing being recorded. All surviving cans were examined at the end of storage. (ii) proved more resistant to heat treatment than (i). Time/temperature conditions ensuring prevention (ii) spoilage without affecting organoleptic quality are graphically presented. Addition of nisin reduced approx 3 x the required temperature exposure time.

Gudkov et al (1973 b) made processed cheese by customary procedures from kostroma, Novyi, Druzhbas Slivochnyi and Rossiyski cheese differing in fat, pH and salt content. Nisin was added as stated there and Clostridium tyrobutyricum and Cl. butyricum isolated from faulty cheeses and Cl. sporogenes 532 (UK collection of type cultures) being added at 100-1000 spores/g cheese. Cheeses in cans and also in Al foil were stored at 16-18°C or 8-10°C and in subsequent experiment, at 22 or 5°C. Incidencess of blow cans and deteriorated cheese were noted. The main findings were spoilage by butyric acid bacteria was liable to occur at 8-10°C within 3 months in cheese containing $>$ 60 % fat in DM and with a pH $<$6, and nisin increased significantly the keeping quality. Onset of spoilage was hastened by increase in pH and fat content of cheeses. Niether Cl. sporogenes

nor Cl. tryobutyricum developed in cheese stored at 5 ± 1°C for ⩽ 245 days; and concn of salt needed to inhibit clostridia development was higher than that organoleptically acceptable.

Processed cheese containing 100 Ru nisin/g (added with the emulsifier during processing) had a shelf lif up to 90 days at 30°C vs. < 30 days for processed cheese not containing nisin. Similary, incorporation of 100 Ru nisin/g into khoa increased shelf by 1 month at 10°C, 3 wk at 22°C and 2 wk at 30°C (Kaira and Dudani, 1973).

El-Sadek et al (1974) found that in processed cheese prepared from 60 % reconstituted dried milk, 37 % minced Ras cheese and 3 % sodium citrate, slight gasiness was detected in the presence of 100 RU but not 200 RU nisin/g. Anaerobic spore count decreased slightly, indicating that spores germinated but could not proliferate. 300 RU nisin/g prevented the formation of visible gasiness in processed cheese inoculated with 1000 Clostridium perfringens spores/g. Total scores for cheese quality after storage for 30 days were 40.6, 68.0, 84.3 and 84.7 % respectively for uninoculated processed cheese containing 0, 100, 200 and 300 RU nisin/g; Corresponding scores for cheeses inoculated with Cl. perfringens spores were : unacceptable, 38.7, 70.7 and 86.0 %.

Experiment carried out in Czechoslovakia on the use of nisin in the form of a dried concentrated in processed

cheese manufacture are breifly described by Hylman (1975). The concentrate now produced commercialy by incubating a mutant of Streptococcus lactis with high nisin-producing capacity in skimmilk for 24 hr and drying. It is called Nislaktin and is added at 2 % by wt to the cheese together with emulsifying salts. The technological process remains the same, but the fact that the SNF content of the cheese is increased by 2 % must be taken into account.

Mahmoud et al (1975) discussed th bacteriological determination of three types of processed cheese manufactured in Egypt namely: Nesto, Siclam and Dimex. Total microbial flora, aerobic mesophilic and thermophilic sporeformers and proteolytic and saccharolytic anaerobes were determined monthly The total microbical flora (10^3 to 10^5/g cheese) was nearly similar to accounts of aerobic mesophilic sporeformers. The most dominant spores of the latter in descending order were B. subtilis, B. megatherium, B. cereus, B. licheniformis, B. sphericus and B. coagulans. Aerobic termophilic sporeformers were present in order of 100/g of cheese in most of the samples. Anaerobic proteolytic and saccharolytic sporeformers were present generally in all the samples, in the order of 10-100/g of cheese.

Yankow (1975) studied kachkoval processed cheese packaged in 400 g cans and stored at 4-6°C (i) after heat treatment at 95°C for 30 min or (ii) after sterilization at 120°C for

20 min. The (ii) cheese were sterile. The initial total bacterial counts/g for untreated and (i) cheese respectively were 4250 and 2600, and anaerobic titres/g were 100 and 100. In (i) after 3 and 6 months, total bacterial counts were 330 and 730/g respectively, and anaerobic titres were 100 and 100/g. It is concluded that (i) cheese can be stored 3-6 months, and (ii) cheeses for 1 yr.

Al-Ashmawy et al (1977) studied 40 samples of processed cheese purchased from retail shops in Cairo and Giza, the mean total bacterial count was 287 x 10^3/g cheese and the mould count 52 ± 7/g cheese. Anaerobic bacteria were present in all samples and Coliform bacteria in only 12.5 %. Bacillus circulans was isolated from 52.5 % of samples, B. subtilis from 42.5 %, B. coagulans from 37.5 %, B. cereus from 32.5 %, B. pulvifaciens from 30 %, B. brevis from 27.5 %, B. lentus from 25 %, B. firmus from 17.5 %, B. megaterium from 15 %, B. stearothermophilus from 12.5 %, B. licheniformis from 10 %, Escherichia coli from 5 %, Enterobacter cloace from 10 %, Ent. liquefaciens from 5 %, Staphylococcus aureus from 5 %, S. epidermids from 30 % and micricocci from 42.5 %. Moulds may recontaminate the cheese during packaging, especially when packaged as slices. Geotrich spp. were isolated from 45 % of the samples.

Teply (1977) found that in Czechoslovakia, nisin is permitted as a preservative in processed cheese at a maximum concentration of 200 RU/g.

Abd El-Hady (1981) discussed a double stage heat treatment method which has been used in manufacturing Trapist cheese. The first heat treatment was used at 85°C for 3 min followed by rapid cooling to 37°C. The second heat treatment was carried out during processing the cheese at 85°C for 6 min. This method prolonged the keeping quality of the obtained processed cheese infected with Clostridium tyrobutricm spores and stored at 37°C for 5 months. Low pH (5.4) and high concentration of sodium chloride (4.9 %) prevented the blowing of the processed cheese produced by the conventional method.

Giori et al (1982) tested 6 samples of processed cheese contaminated during manufacture and 3 samples of material from the processing machine for anaerobic bacteria. 60 strains isolated were all catalse-negative, strict anaerobes with subterminal spores; 50 of these strains were Gram-postive and identified as Clostridium butyricum or Cl. tyrobutyricum and the remaining strains were Gram-negative and identified as Desulfitomaculum ruminis.

Aleksieva et al (1985) examined 136 samples of processed cheese of 8 types (with tomato puree, savory, gherkins, etc.) for microflora. 99 samples had counts of mesophilic bacteria up to 200,000/g. Only 2 samples (both 8 smoked, pickled type) had a coliform titre < 0.1, and only 6 samples had an enterococci count $> 100,000/g$. Tests for salmonellae gave 25/g and

Emulsifing salts:

Emulsifying salts(Joha brand) was obtained from Fibrisol Ltd., London, UK.

A mixture of Joha SE, C and T was used in the blending process. The specification of these salts is shown in the table.

No.	Joha type	1 pH 1% solution (± 0.2)	2 Neutralising Figure(N)	3 Soxhlet-Henkel Value	4 pH displacement	5 Recommended Rate of addition*
1	SE	9.0	-710	-190	+0.2/+0.4	1.25
2	C	4.0	+190	+350	-0.2/-0.4	1.00
3	T	11.7	-2500	-1880	+1.0/+1.5	0.75

Foot note:

Data compiled from product specification sheet supplied by Joha company.

* Based on recommendation by the supplier of emulsifying salts (Joha company).

1- The pH measurment was determined in one percent solution at 20°C.

2- The neutralising capacity (N Figure) was defined as the amount in ml of N/4 sodium hydroxide (+) or N/4 Hydrochloric acid (-) necessary to neutralise 100g of processed cheese to a pH value of 7.0 and these are according to the nature of the tested salts.

3- The Soxhlet Henkel value (SHZ) was defined as amount in ml of N/4 sodium hydroxide or Hcl (-) necessary to reach the transition

point of the phenolphthalein indecator which lies at pH 8.4.

4- pH displacement is the PH observed in the end product.

Nisin:

Free sample of Nisiplan from Aplin and Barretted, Trowbridge, Wiltslire, England, was used in preparation of processed cheese as a preservative. Activity of nisin was expressed as 1,000,000 RU/g and it was added at a rate of 100 mg/kg processed cheese (100 RU/g).

Savorase-A enzyme. (Aminopeptidase enzyme from Streptococcus lactis subsp. lactis:

Free samples of savorase- A enzyme from Imperial Biotechnology limited, Imperial College Road, South Kensigton, London SW7 2BT, U.K. This enzyme was added to the curd to hydrolyse the protein and accelerated the ripening of cheese. The activity of the enzyme was 5.3 FLAP units/g and it was added at a rate of 16.2 - 16.5 g /kg curd.

Starter culture:

A feeze-dried mesophilic cheese starter culture (Ezal-1 MAOIIC) was used to ferment the skimmilk retentate. This culture was obtained from Eurozyme Ltd, London, U.K. This was one of the suitable cultures for direct to vat- inoculation (DVI). It consisted of a mixture of Str. lactis subsp. lactis and Str. lactis subsp cremoris.

METHODS:

Manufacture of Cheese Base:

The following schematic illustrated the manufacture steps of cheese base:

I st day
1- Reconstitute skimmilk powder(20% TS)at 40°C.
2- Ultrafiltrate the skimmilk to concentrate mainly the protein fraction using DDS plant Fig (1).
3- Added water(equal to the resaltant permeate) and diafiltrate to remove excess lactose.
4- Pasteurized UF concentrate at 72°C for 15S, cool to 10°C and store overnight.

2nd day
5- Pre-warm UF concentrate to 30°C, inoculate with starter culture and ferment to pH 5.8.
6- Add rennet and coagulate the concentrate in Alcurd machine Fig (2).
7- Deliver the curd cubes into a conventional cheese vat, stir gently by hand and when sufficient whey occur, heat gently to 39°C.
8- Drain surplus whey and divide the curd into two equal portion.

Cheese base I	Cheese base II
Mix with salt, fill in moulds and press overnight	Mix with salt and enzyme(savorase) full in moulds and press overnight
Package under vacuum and store in refrigerator until required.	Package under vacuum and store in refrigerator until required.

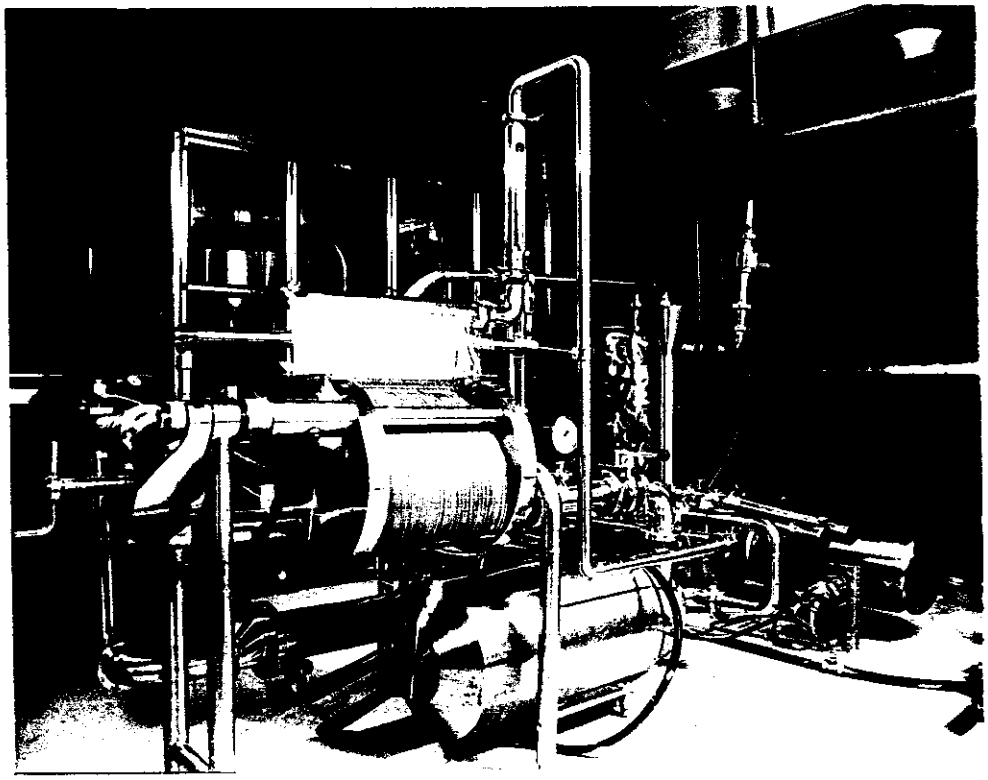


Fig (1) Ultrafiltration Unit (DDS membrane).

Manufacure of processed cheese:

Cheddar cheese of different ages, cheese base I and cheese base II were cleaned, cut and sharded:

Different proportions of Cheddar cheese from different ages, cheese base I and cheese base II were mixed and placed in the processing batch type kettle of 20 kg capacity (stephens machine) as shown in Fig (3). Kettle was equiped with double action agitator and a vacuum pump. The cheese blend was heated in the kettle with direct injection of steam at a pressure of 3.5 kg/cm^2.

The composition of the blend was adjusted for fat by adding anhydrous milk fat, and for moisture by adding the calculated amount of water , to obtain a finished product with 50 % water as a maximum and 45 % F/DM as a minimum, this to fit the requirment of the Egyption standards for the processed cheese (1970). The emulsifying salts were added at a level of 3 % "Joha Salt" which consists of 1.25 % SE, 1 % C and 0.75 % T. The heating temperature of 85 - 90°C was attained within 2 - 3 min, using the vacuum for 1 min and held the temperature at 85 - 90°C for 2 min, the hole processing time was about 5 - 6 min.

Filling and packaging:

At the end of processing operation the hot processed cheese was manually filled in Pukkafilm pouches(Moisture Vapoure transmission rate was 0.8 up to 1 g /M^2/24 hrs at 25°C and 75 % RH and Oxygen permeability less than 20 cc/M^2/24 hrs at 20°C and 0 % RH) which lined cardboard boxes of about 2 kg capacity. Then, it was sealed and held at 4°C for 3 days.

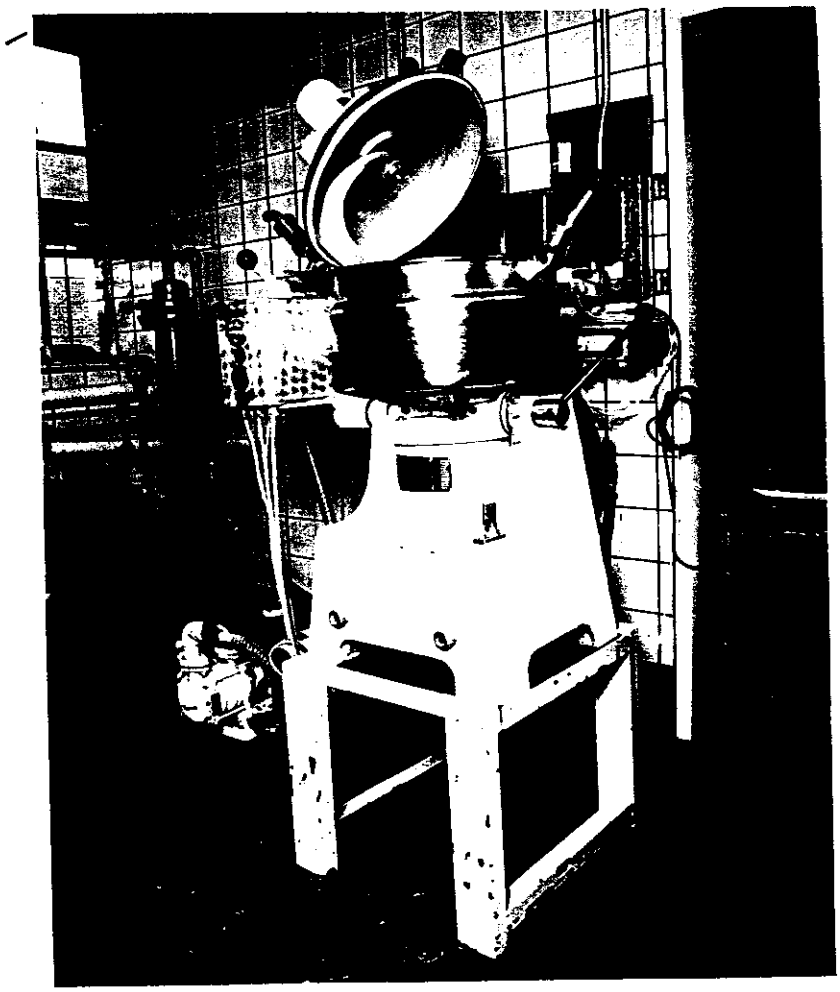


Fig (3) Cheese processing kettle (Stephan Universal Machine)).

METHODS OF ANALYSIS:

Methods for Evaluation of Physical Properties of Processed Cheese:

1- Oil separation:

Oil separation was determined according to Thomas (1973) and it could be summarized in the following:

a) A cork borrer was used to obtain cylindrical samples of processed cheese, approximately, 17.0 x 17.0 mm.

b) The sample was pressed gently between a Whatman filter paper No. 41 and incubated at 45°C for two hours.

c) The diamter of the spread oil was measued in mm and was used as an index of oil separation as follows:

$$\text{Index oil separation} = \frac{\text{Diometer of cheese after heating} - \text{Diometer of cheese before heating}}{\text{Diometer of cheese before heating}} \times 100 \quad (1)$$

d) All measurments were made triplicates.

2- Melting index:

A) Melting index of survey study:

Melting index in the survey study was carried out according to Olsen and Price (1958) which can be concluded as follows:

Apyrex glass tube (25 mm diameter and 250 mm length was used to hold the spreads during the melting test. One end of this melting tube was perforated (2 mm diameter) to act as avent. The other end was closed with a rubber stopper after placing the sample into the tube. The tested sample was tempered to 5°C with a known

d) Then the samples were removed and allowed to stand at room temperature for 15 min before storage at $10^{o}C$ for 30 min.

e) The hight of the cheese cylinder(i-e in the centre) was measured and the melting index calculated expressed as a percentage decrease in hight according to the following equation:

$$\text{Melting Index \%} = \frac{H_1 - H_2}{H_1} \times 100 \quad \ldots\ldots\ldots(3)$$

H_1= hight of cheese sample in mm after sampling.

H_2= hight of cheese sample in mm after heating.

3- Penetrometer reading:

A) Penetrometer reading of survey study:

An available method in Egypt was used for the determination of processed cheese firmness during the survey study according to Gouda (1980). The used penetrometer in this study as shown in Fig (4) consists of:

(1) Needle ended by two screw, one for each side. The supper screw was used to adjust the load while the lower to attach with penetration parts, which have wide end maximum depth of penetration for this penetrometer was 1 cm.

(2) The penetrometer was caliberated into 10 unites, each unit was divided into 100 parts, each part was of 0.01 mm.

A sample of processed cheese was poured, when hot, or pressed, when cooled and solidified to fill a small alluminum dish of about 6 cm diameter, and 3 cm in depth. The penetrometer needle was adjusted to touch the surface of the processed cheese sample in aluminum dish. The needle was

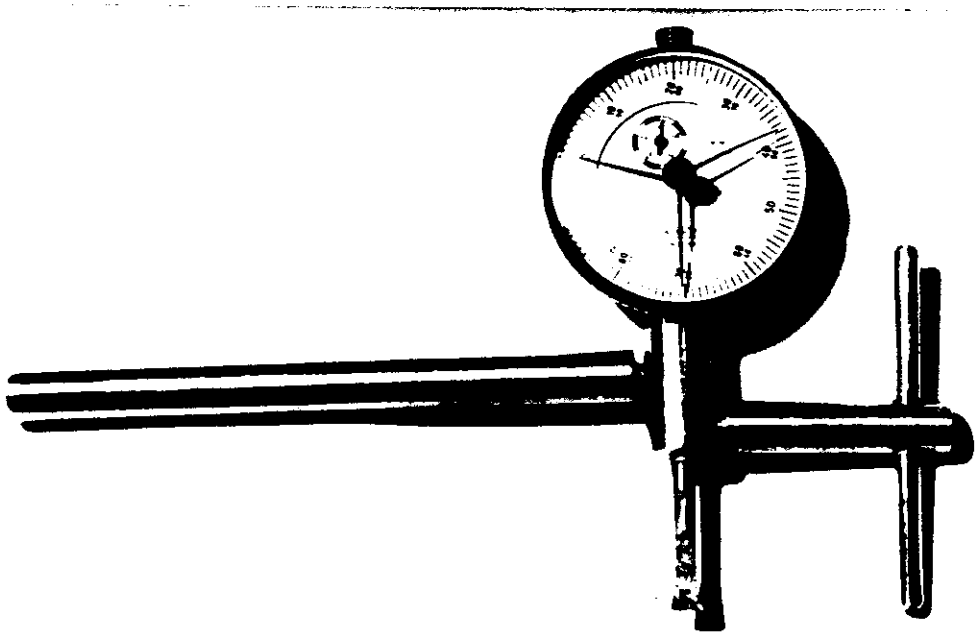


Fig (4) Penetrometer (A) for measuring the firmness of processed cheese.

then released to sink into the sample for exactly 5 or 10 S where it was stopped by the special screw. The penetration depth was recorded in unit of 0.1 mm. The measurment was repeated 5 times using five different position in the same dish. The average of these replicates was recorded. Penetrometer reading is related inversly to the firmness of processed cheese.

B) Penetrometer reading of block processed cheese:

An available method in Scotland was used for the detemination of block processed cheese firmness by a penetrometer which can be seen in fig (5) where a spindle/cone assembly for a certain weight was allowed to penetrate the sample. The depth of penetration was measured in 1/10 mm and in general the greater the depth of penetration the weaker the body of cheese.

This penetrometer was supplied by Stanhope Seta, Ltd. Surrey KT 16 8 BG , England, UK. The spindle and cone assembly weighted 50 + 10.32; However the cone used was designed by ime (1977). According to Thomas et al. (1970) the test was formed as follows:

1) Cut processed cheese sample into a 20 mm cubes.

2) Put the sample on the base and move the sleeve down until the tip of the cone just rest on the cheese.

3) Move down the racked dial rod until it contacts the top of the spindle.

4) The pointer adjusted at zero and then use control box to adjustment i.e. the timer for 10 S.

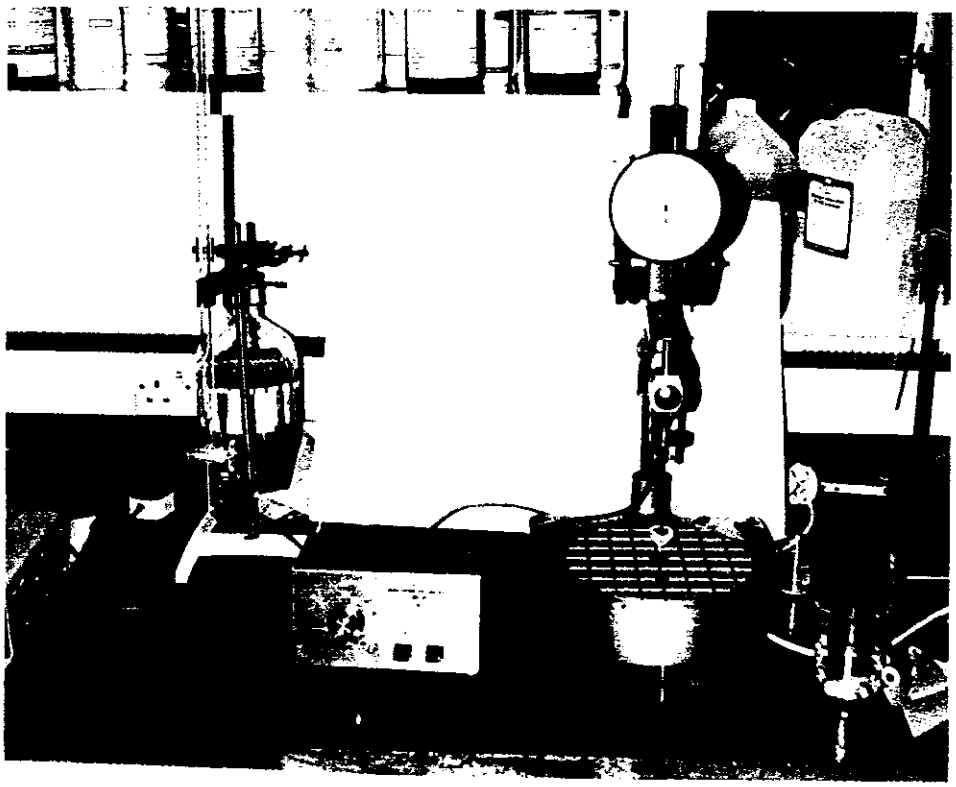


Fig (5) Penetrometer (B) for measuring the firmness of processed cheese (Seta Penetration Equipment).

5) The spindle/cone assembly was released from holding position and freed for 10 S. During such period the cone penetrates the cheese.

6) The penetration depth was measured by moving the rod downwards to restore contact with cone/spindle. The distance moved by the rod was registered on the dial which was equal the actual penetration of the cone into the cheese sample. The readings are in 1/10 mm.

4- Consistency measurement:

The Stevens-LFRA Texture Analyser (C. Stevens and Son (weighing machines) Ltd, Laboratory Division, 2 - 8 Dolphin Yard Holy well Hill, St Albans. ALI IEX Hertfordshire, UK)which is shown in fig (6) was used to measure the processed cheese consistency. The cheese sample was prepared and tested as follows:

1) Set instrument on a solid and level surface.

2) Check that the electrical supply is correct and plegged in.

3) Press red bottom " supply " and allow the electronics and read-out to stabilise.

4) Set the digital read-out to read 000 by turning "zero"knob and the type of cone was TA26/TFE-105-524Y.

5) Set distance of penetration required (15 mm).

6) Set speed of penetration required (0.5 m/sec).

7) Switch to the required type of test (normal).

8) A cube of cheese sample 50 x 20 x 20 mm was prepared and tempered at 6°C approximately.

9) Place sample on the table and adjust it so that the probe (cutter wire) was not less than 10 mm from the surface of the tested sample.

10) Press " Start " buttom.

11) The instrument will now perform the tested for which it has been set.

12) The load recorded at the preselected distance of travel would be held on display (i.e. in g) until the "reset" bottom was pressed. The display will then return to 000 and the instrument would ready for another test.

13) The load could be also continuously recorded as a function of penetration distance during the course of a test using chart recorder.

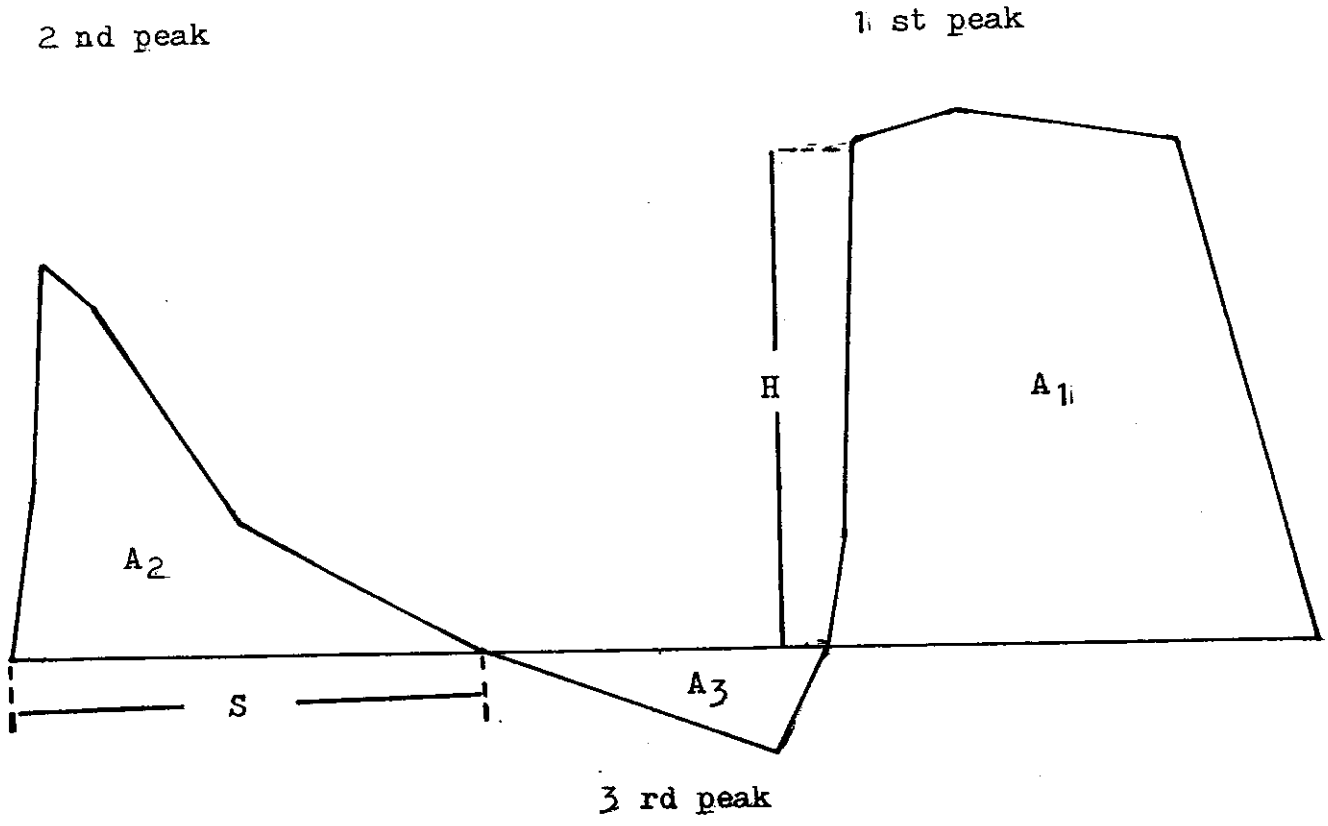
5- Texture profile analysis (Instron measure):

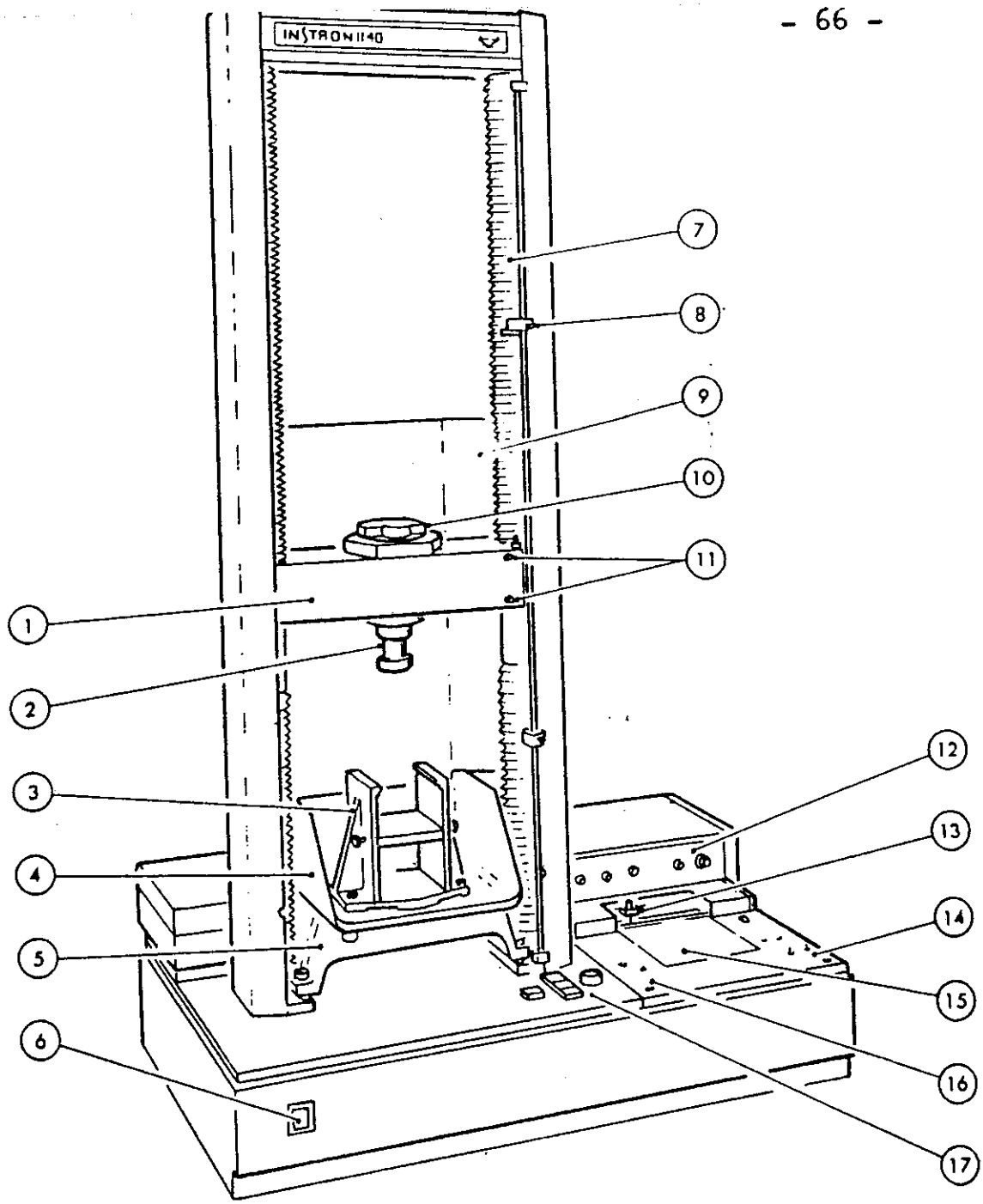
The texture profile analysis was measured using the Instron Universal Testing Machine, Model 1140 from Instron limited, coronation Read, High Wycombe, Bucks, HP 12 35 Y, UK. The load cell, ranged from 0 to 50 kg. A plunger with a diamter of 1.20 cm was attached to the moving crosshead.

The speed of the crosshead was set at 2.5 cm/min in both upward and downward directions. The processed cheese samples were cut into rectangular cubes with dimension 2.5x3.5x5.5 cm, placed in plastic pouches and heat sealed to minimize any of moisture loss and stored at 6°C for 24 hrs.,

The processed cheese samples were placed between two flat perspex glass where the side had a hole in the middle. The penetration of the plunger into sample was set for one cm. One bite was cycle of a downward plus upward motion of the plunger which penetrated into and immediately was retrieved from the sample. Two bites were taken. An illustration of the apparatus can be seen in Fig (7).

By using the Instron machine, the following texture measurments could be calculated and recorded as : hardness, cohesiveness, gumminess, springiness, chewiness and adhesiveness. According to (Friedman et al.(1963); Chen et al(1979) and Harvey et al.(1982), these characterstics could be calculated as follows by using a Typical print out of the texture profile of the processed cheese.





1. Moving Crosshead
2. Fixture Adaptor
3. Sample Support Assembly
4. Drip Tray
5. Compression Bridge
6. Mains Pushbutton
7. Drive Screw Covers (2)
8. Limit Stops (2)
9. Splash Guard
10. Load Cell
11. Limit Indicators
12. Load Cell Amplifier
13. Recorder Pen Assembly
14. Recorder Controls
15. Recorder Chart
16. Event Marker Controls
17. Crosshead Controls

Fig (7) Apparatus assembly to measure textural characteristics of block processed cheese (Instron Universal Testing Machine, Model L 1140).

A) Hardness = H x F .....(4)

H = hight in cm of the first peak.

F = constant factor. which is 0.263 or 1.053 when the used load was 5 or 10 kg respectively.

B) Cohesiveness = $\frac{A_2}{A_1}$ ..... (5)

A_1 and A_2 are the area of the bites calculated by using the planometer $\cong$ to cm^2.

C) Gumminess = Hardness x Cohesiveness ..... (6)

or or H x F x $\frac{A_2}{A_1}$ kg/cm^2

D) Springiness = S ..... (7)

S is the distance in cm of the cheese sample under compression during the second peak.

E) Chewiness = Gumminess x Springiness .....(8)

or H x F x $\frac{A_2}{A_1}$ x S

F) Adhesiveness = the area of peak A_3 .....(9)

measured by using the planometer to cm^2

6- Colour determination:

Processed cheese colour was determined according to Thomas (1969):

Reagents:

1- Trypsin (10 %): Weigh 10 gm of trypsine(BDH) in 100 ml volumetric flask and make up to the mark with distilled water.

2- 50 % Trichloroacetic acid (TCA): Weigh 50 gm of TCA in 100 ml volumetric flask and make up to the mark by distilled water.

Procedure:

1- Weigh 10 g of cheese emulsify in distilled water at 50°C, adjust pH to 8.1 – 8.4 and volume to 100 ml.

2– Add 0.75 ml trypsin , incubate for 1 hr at 10°C and add 1 ml TCA. Hold the mixture for another 1 hr at 40°C to overcome turbidity.

3- Filter through whatman paper No 42 and determine optical density (O.D) immediately at 301 µm against blank using Ultraviolet spectrophotometer model Unicam SP 1800 with SP 1825 Autocell (Pye Unicam Ltd., Cambridge UK.)

Chemical Analysis:

1- Moisture content:

The moisture content was determined according to British Standards method (BSI,1976).

2- pH values:

This was measured according to the BSI (1976) pH values using pH meter model Philips PW 9409 digtal (Philips Ltd. UK) by inserting the pH electrod in the cheese directely and the pH value was reported to the nearst 0.01 units.

3- Fat content:

A) Survey study:

Fat content in survey study was determined according to Ling (1963).

B) Cheddar cheese and block processed cheese:

Fat content was determined using the Gerber method BSI(1969).

4- Salt content:

Salt content was determined according to British Standard method (BSI, 1976).

5- Ash content:

The ash content was determined according to IDF (1964).

6- Total nitrogen (T.N):

The method of Kosikowski (1977) using a kjeltec Auto 1030 Analyzer (Tecator Ltd, Cooper Road, Thornbury, Bristol, UK.) was adopted in determining the T.N. content.

7- Non protein nitrogen (N.P.N.):

Non protein nitrogen was determined according to Ling (1963).

8- Soluble nitrogen (S.N.):

Soluble nitrogen content was determined according to KosiKowski (1977) as follows:

Reagent:

Sharp's extraction solution: First prepare stock solution from 57.5 ml Glacial acetic acid, 136.1 g of sodium acetate.$3H_2O$, 47.0 g sodium chloride, 8.9 g calcium chloride (anhydrous) and add distilled water to make up to 1 litre. Second prepare extraction solution by using 250 ml stock solution up to 1 litre with distilled water. The pH of this solution was 5.5.

Sample preparation:

1) Place 10 g of sample in a porcelain morter. Add a small amount of sharp's extraction solution tempered to 50°C and grind

the cheese sample to form a thick paste. Add more solution until the paste is liquid.

2) Transfer the liquid suspension to a 100 ml volumetric flask to make up to the mark and place the volumetric flask in a water bath at 50°C for 1 hr.

3) Filter the solution through whatman paper No. 42.

Procedure:

Digest 5 ml filtrate by micro-Kjeldahl method using automatic distillation and titration.

9- Lactose content:

Lactose content was determined by differences as follows:

Lactose = Total solid - (Fat + Protein + Ash).....(10)

10- Total calcium:

The method of Raadsveld and Klomp (1971) was adopted to determine the total calcium content.

11- Phosphorus content:

The phosphorus content was determined according to British Standards method (BSI 1976) as follows:

Reagents:

1- Concentrated sulphuric acid (density 1.84 g 1 ml)

2- Hydrogen peroxide (H_2O_2) 30 % (w/v) solution.

3- Sodium molybdate - hydrazine sulphate reagent consists of 25 ml

of sodium molybdate(12.5 g of sodium molybdate in 10 N sulphuric acid to volume of 500 ml) and 10 ml hydrazine sulphate (0.3 g of hydrazine-sulphate in water up to 200 ml.). This solution cannot be stored.

4- Phosphate standard solution: Weigt 0.439 g of potassium dihydrogen orthophosphate and dilute to a volume of 1 litre. This solution contains 100 µg of phosphorus per 1 ml. Dilute 10 ml of the standard solution with water to a volume of 100 ml. The drying of potassium hydrogen orthophosphate was carried out.

Procedure:

1- Weigh 0.5 g of the sample into a Kjeldahl flask and add 4 ml of concentrated sulphuric acid, then heat the Kjeldahl flask carefully on the digestion apparatus.

2- As soon as the foaming stops, cool to room temperature, then add some drops of the hydrogen peroxide solution. Reheat, and repeat this procedure until the contents have become clear and colourless. During the heating, mix the contents from time to time. To prevent any troubles, avoid over heating.

3- Rinse the neck of the flask with about 2 ml of water, then heat the contents again until the water has been evaporated, allow the liquid to boil for 30 min, after it has become clear, in order to destroy any traces of hydrogen peroxide.

4- After cooling to room temperature, add approximately 50 ml water, mix, and after cooling again transfer the liquid contents into a 100 ml volumetric flask and made up to the mark with distilled water and mix.

5- Transfer 1 ml of the solution into a 50 ml volumetric flask and dilute with 25 ml of water. Add 20 ml of the sodium molybdate

hydrazine sulphate reagent and make up to the mark with distillid water and mix. Place the flasks in boiling water and allow the colour to develop for 15 min.

6- Cool to room temperature by using cold water and measure the absorbance within 1 hr against a blank at a wavelength of 700 nm by using an ultraviolet sepectrophotometer model Unicam SP 1800 with SP 1825 Auto cell (Pye Unicam Ltd., Cambridge, UK).

7- To prepare a calibration curve place in 50 ml volumetric flasks, 0, 1, 2, 5 and 10 ml respectively of the diluted phosphate standard solution to provide a suitable range of standards containing 0, 10, 20, 50 and 100 µg of phosphorus and proceed as described above.

8- Prepare the calibration curve by plotting the absorbance against the quantity of phosphorus in micrograms (Fig 8)

9- Calculation of the phosphorus content:

$$\text{Phosphorus content} = \frac{m_1}{100\ mo} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

where mo: is the mass, in g of sample.

m_1: is the mass of phosphorus, in µg by convert the reading obtained to µg of phosphorus using the calibration curve Fig(8).

12- Determination of mineral content of processed cheese:

Analysis of mineral content included the determination of macro and micro elements in processed cheese according to Mohamed (1987).

Preparation of samples:

The weigh ash transefered quantatively from the crucible to 100 ml volumeteric flask with a solution of 1 % HCl and the volume was completed to the mark.

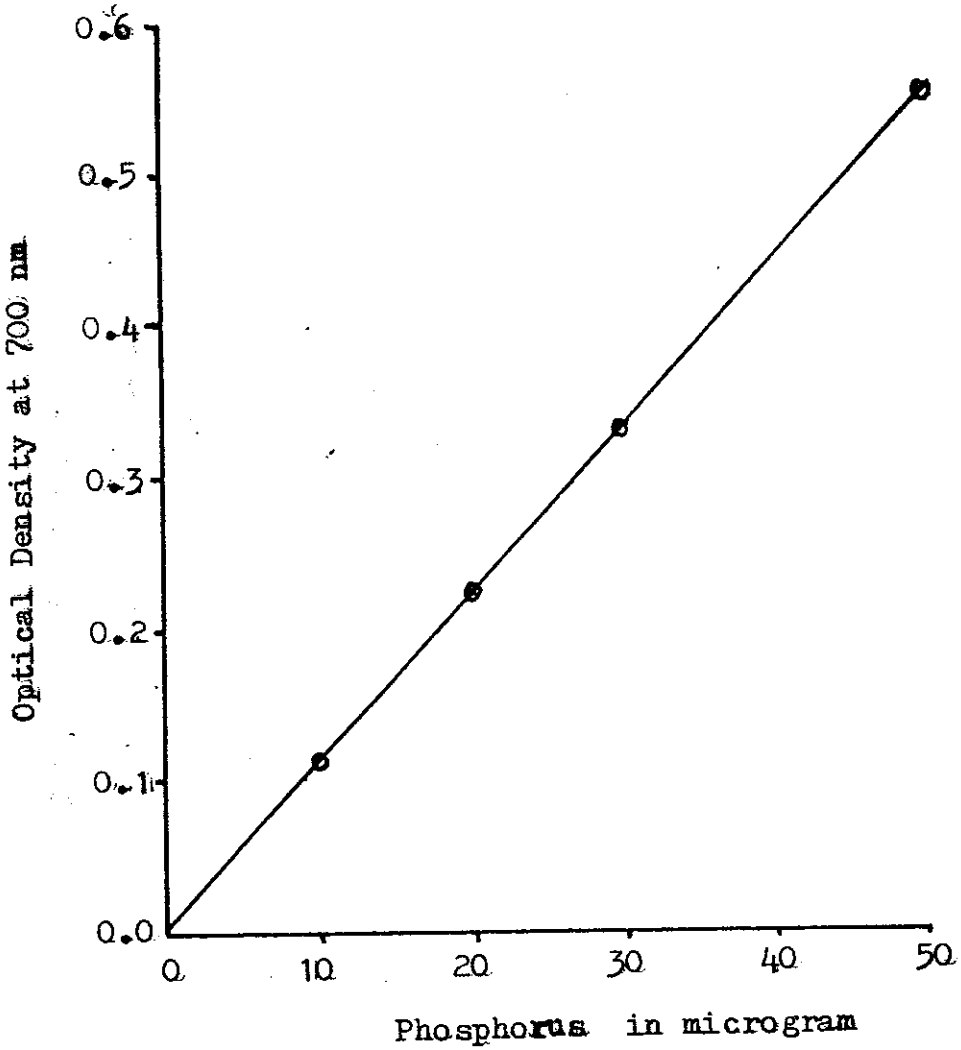


Fig (8) Calibration curve for the determination of the phosphorus content in cheese samples.

Solutions and reagents:

All glass equipments were cleaned thoroughly and rinsed successively with a solution of 1 % EDTA, followed by a solution of 10 % nitric acid then distilled-deionized water. Only double glass deionized water was used in preparing standard solution of samples. Blank solution was prepared using 0.1% Hcl. Solutions of samples, blank and standards were kept in polyethylene plastic containers until analysis. Spectrographically certified reagents or atomic absorption grade standard solutions for elements were only used as stock standards.

Preparation of standarad solutions:

Aliquot of stock solutions were used to make at least 10 standard solution for each element within the range of instrument (A range of 0.02 – 50 ppm according to the detection limit of instrument). Dilute standard solutions were prepared freshly and kept in polyethylene plastic containers.

Apparatus:

Determination of elements was performed using atomic absorption Spectrophotometer (Chromspek Model 1580, Hilger Analytical, England) equipped with digital panel meter display, automatic zero system, concentric nebuliser (H 1562), automatic curve correlation, automatic back ground correlation device, automatic sampler device digital printer with programmable

calculating system, and single pen-chart recorder. Hilger hollow cathode lamps were used determining level of elements analyzed.

Operating conditions:

All elements were determined at the flame adsorption mode with pretime delay system in conjunction with automatic zeroing. Blank solution was used to zero the instrument and to flush the burner. Standard and sample solution were aspirated into flame and percent absorption were recorded.

Caliberation curves:

A liner standard curve was obtained for every element analyzed and all sample sizes and concentration were adjusted to fall within this range. Concentration for diluted standard solutions were plotted against their respective absorption values so as to prepare the working analytical curve.

Calculation:

Concentration of elements in samples in ppm (µg/g) were calculated using the following equation:

$$\text{Element, ppm} = \frac{(\ \mu\text{g element/ml from curve} \times D\ )}{W}$$

where:

W = g sample

D = 100 ml if sample solution was not diluted but if

$$\text{diluted } D = \frac{\text{Final volume}}{\text{Volume of aliquot}} \times 100$$

13- Total volatile fatty acids (TVFA):

The total volatile fatty acids in processed cheese were determined by direct distillation method described by KosiKowski (1977).

14- Sulphosalysilic acid (SSA) soluble nitrogen:

Sulphosalysilic acid soluble nitrogen content in natural cheese,and cheese base was determined according to Imperial Biotech (1988). The proteins and peptides are precipitated to leave free amino acids in sample. A standard curve using glycine was prepared and results were expressed as glycine equivalents (µg/ml).

Reagents:

1- Sulphosalysilic acid (SSA solution 3 % (w/v)): Weigh 3 g SSA in 100 ml volumetric flask and make up to the mark with deionized water.

2- 0.1 M Borate buffer pH 8.5 : Weigh 22.37 g potassium chloride (Kcl) and 6.18 g boric acid (K_3BO_3) in 1 L volumetric flask and make up to the mark with deionized water and adjust to pH 8.5 with Sodium hydroxide (NaOH).

3- 0.1 % 2,4,6 trinitrobenzene sulphoric (TNBS): Weigh 0.1 g TNBS in 100 ml volumetric flask and make up to the mark with deionized water.

Sample preparation:

1- Homogenize 5 g cheese sample in 20 ml deionized water using the stomacher shaker (Colwort stomacher 400 UK) for 5 min, filter the resulting suspension through cheese cloth to remove fat and collect the filtrate.

2- Centrifuge approximately 1.5 ml of the filtrate in eppoder tubes at 13,000 rpm for 10 min.

3- Add 1 ml of the filtrate to 5 ml of 3 % SSA, mix and leave at $4^{o}C$ overnight to ensure good precipitation of protein and peptides.

4- The next day, centrifuge a small aliquot of each sample at 13,000 rpm for 5 min.

Assay procedure:

1- Pipette the following into a cuvette, and incubate at $32^{o}C$ for 25 min.

- 50 uml of prepared cheese sample suppernatant (as previousely described).
- 1 ml TNBS solution (should be freshly used).
- 3 ml 0.1 M borate buffer pH 8.5.

2- A calibration graph may be constructed using glycine concentrations between 50 - 100 µg/ml, and proceeding with the TNBS assy as described above.

3- Read samples against a borate buffer (consisting of 3 ml of borate buffer, 1 ml TNBS and 50 uml 3 % SSA using ultraviolet spectrophotometer model Unicam SP 1800 with SP 1825 Autocell (Pye Unicam Ltd., Combridge U.K) at A420 nm.

4- Convert O.D readings to glycine equivalents (µg/ml) using the calibration graph Fig (9).

15- Polyacrylamide gel electrophoresis (PAGE):

Electrophoresis is a method that utilizes charge difference for the separation and purification of protein (Haschemyer and Haschemyer, 1973; Ridha, 1984). PAGE was used in the indentification and comparison of casein fractions and hydrolysed.

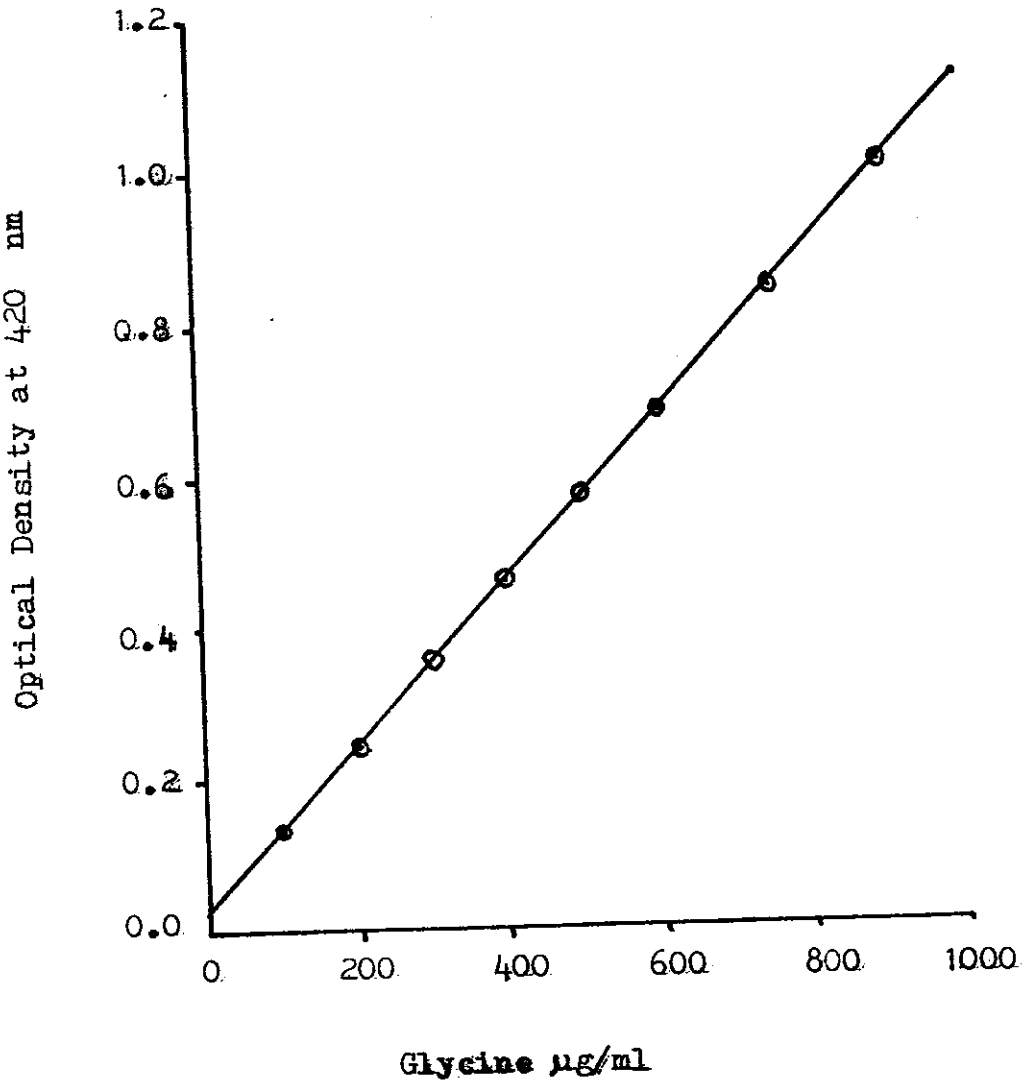


Fig (9) Calibration curve for determination of glycine equivalents (µg/ml)

Reagents:

1- Gel-Buffer (GB): Weigh 4.59 g of tris hydroxymethylamine, 0.53 g citric acid and 270.270 g urea, dissolve in distilled water and make up to 1 litre.

2- Seperating gel-solution: Weigh 8 g cyanogum in 100 ml of G.B, 0.15 g ammonium persulphate, 150 µml mercaptoethanol and 0.2 ml dimethylamine propionitride (DMAPN)(the later compound must be added finally).

3- Buffer solution: Weigh 18.5 g boric acid and 2.8 g sodium hydroxide, dissolve in 600 ml distilled water, adjust pH to 8.6 and make up to 1 litre with distilled water.

4- Stainer Solution; Weigh "Coomassie blue R" and dissolve in 100 ml 10 % acetic acid (v/v).

5- Destainer solutions: Prepare 5 % acetic acid (v/v).

Preparation of the samples:

1- Weigh 100 mg of grated cheese or 50 mg of grated cheese base or 20 mg sodium caseinate in a centrifuge tube with 0.1 ml distilled water and 3 ml of G.B.

2- Warm the mixture to 42°C for at least 30 min and stirr for 4 min to disperse the particles in the sample. Centrifuge the tube at 3000 rpm for 10 min.

3- Transfer a portion of the supernatant by using "Pasteur" pipettes to the PAGE cell and add 20 µml of mercaptoethanol.

Procedure:

1- Prepare the separating Gel-solution directly before use. Mix very gently, deareate and pour into vertical slab electrophoretic

9- Pakage the clear gel in a nylon polyethene laminate pouch (i.e. vacuum and heat seal), store in the refrigerator until required for comparative studies or to be photographed.

Sensory Evaluation of Processed Cheese:

The processed cheese sample were organoleptically evaluated when fresh and during storage period at 10°C, according to scheme reported by Meyer (1973) with some modification as shown in Fig (10).

The evaluation was carried out by a 10 trained panelists of members staff in the Food Technology Department of the West of Scotland College Auchincruive, Ayr, Scotland, U.K.

Microbiological Determinations:

Microbiological sampling:

Samples of the different processed cheese or treatments were taken according to BSI (1984) as follows:

Weigh 10 g of cheese sample in sterile plastic bag and add 90 ml of 2 % sodium citrate at 45°C ± 1.0. Homogenize the mixture in stomacher shaker (colworth stomacher 400, Blakfri as Road London, U.K.) for 2 min. Thus, the cheese sample + sodium citrate is≙ to 10^{-1} dilution. Prepare serial of tenfold dilution by using sterile Ringer's solution.

The Ringer solution consists of:

Sodium chloride 2.25 g.

ORGANOLEPTIC EVALUATION

Tester:-

Date:-

Sample No./Code	Outer Appearance and Colour		Inner Appearance (Body and Texture)		Flavour and Aroma		Overall Score	Acceptability
	Score (4)	Comments	Score (8)	Comments	Score (8)	Comments		

Defects are

Appearance and Colour:- Cleanliness, mould growth and unnatural colour

Body and Texture:- Rough, grainy, thin in the body, not firm enough, too firm and hard.

Flavour and Aroma:- Flat, sharp, bitter, rancid, soapy, salty, putrid, musty, metallic, burnt, tallowy and yeasty.

Fig (10) Evaluation sheet used for panel judgement.

Potassium chloride	0.105 g
Calcium chloride (anhydrous)	0.050 g
Sodium hydrogen carbonate	0.050 g
Distilled water up to	1000 ml

When ringer tablets is available, dissolve one tablet in 500 ml distilled water and dispence into the required amount, sterilize in autoclave for 15 min at 121°C. While sodium citrate solution consists of 20 g/L.

1- Total count BSI (1984):

Total bacterial count per g. of Cheddar cheese, cheese base or processed cheese were determined by plating suitable dilution in duplicate on tryptone glucose yeast extract agar medium (oxide). The plates were incubated at 32°C for 3 days before counting.

The used medium consists of:

Yeast extract	2.5 g
Tryptone	5.0 g
Dextrose	1.0 g
Agar	9.0 g
Distillid water up to	1000 ml
pH =	7

2- Yeasts and moulds:

yeasts and moulds count were determined by plating a suitable dilution in duplicates on yeast extract dextrose chloramphenicol medium (BSI, 1986). This plates were indicated at 25°C for 3 days before counting. The used medium consists of:

Yeast extract	5.0 g
Dextrose	20.0 g

Chloramephenicol	100.0 mg
Agar	15.0 g
Distillid water up to	1000.0 ml
pH =	6.6

3- Aerobic sporeformers counts:

They were determined according to BSI (1986). The suitable dilution were heated to 80°C for 10 min and cool the sample immediately to 10°C, plate on starch agar and incubated at 33°C for 3 days and recording the results. The used medium consists of:

Lamb-lemco-powder	1 g
Yeast extract	2 g
Peptone	5 g
Sodium chloride	5 g
Agar	15 g
Distilled water up to	1000 ml
pH =	7.4

4- Anaerobic sporeformers count:

Anaerobic sporeformers were determined by the method of BSI (1986). Heat dilutions at 80°C for 10 min and cool the samples immediately to 10°C. Each dilution was inoculated in three tubes (1 ml each) of cooked meat medium. The tubes were sealed with a layer of 2 % agar maintain anaerobic condition. The tubes were then incubated at 37°C for 7 days. Positive tubes according to Oxide (1979) can be divided into main groups by their action on the used medium

A) Saccharolytic organisms:

There is rapid production of acid and gas which push strongly the agar layer but no digestion of the cultures may have a slightly smell and with reddened protein.

B) Proteolytic organisms:

Proteolytic causes decomposition of the meat with the formation of foul smelling, sulphur compounds and blackening.

The most probable number was then calculated using the specific BSI tables (1984). The cooked meat medium consists of:

Heart muscle	459 g
Peptone	10 g
"Lab-lemco" powder	10 g
Sodium chloride	5 g
Dextrose	2 g
Distilled water up to	1000 ml
pH =	7.2 ± 0.2

When medium tablet are available, add one tablet to 10 ml of distilled water in a narrow container. Soak for 15 min and sterilize by autoclaving at 121°C for 15 min.

6- Detection of coliforms BSI (1987):

Coliforms were detected by inoculating 1 ml 10^{-1} dilution into every tube which containing 5 ml Maclonkeny broth in

triplicates. The tubes were incubated at 32°C for 24 hrs. Tubes showing the presence of acid and gas considered as positive.

The used medium consists of :

Bile salt	5.00 g
Peptone	20.60 g
Sodium chloride	5.00 g
Lactose	10.00 g
Bromol cresol purple	0.02 g
Distilled water up to	1000.00 ml
pH =	7.4

Statistical Analysis:

Statistical analysis were carried out in the presnt study according to Yaomans (1976).

Evaluating The Local and Imported Processed Cheese:

INTRODUCTION

During the last years there has been a continuous rise in the production of processed cheese and processed cheese foods. New types have appeared on the market and there has been steady public demand for these and also for the more traditional varieties. The local production from these commodities are much less than the needs. This encouraged the importion of processed cheese and related products from different sources. The acceptability of the various brands of processed cheese by the Egyptian consumers varied widely. A part from the informations give by the producers, little is known about the composition and properties of the different processed cheese in the local market. The informations given on the lables of the processed cheese available in the local market are not enough to classify them and to evaluate these cheeses, chemically and bacteriologically.

So, the objective of this part was to give an idea about some chemical, physical and microbiological quality of the "market" processed cheese.

EXPERIMENTAL

Thirty eight processed cheese samples wew randomly collected from the shops and soppermarkets in Cairo. These

samples represent 13 brands of locally and imported varieties.

Processed cheese samples were analysed chemically for pH, acidity, T.S, fat, salt, ash, lactose, T.N, S.N, N.P.N, T.V.F.A and minerals (sodium, phosphorus, calcium, potassium, magnesium, manganese and zinc). Some physical properties including melting index and penetrometer reading were determined. The bacteriological quality of the cheese samples were also examined by determining, total count, aerobic sporeformers (saccharolytic and proteolytic).

The results were evaluated statistically.

RESULTS AND DISCUSSIONS

I- Chemical Composition:

pH and acidity:

It was observed from table (1) that pH value varied in a narrow range and it was somewhat higher in local cheeses than imported ones being 5.48-6.25 with an average of 6.00 and 5.78-6.03 with an average of 5.91 respectively. The acidity was ranged from 1.2-1.5 % in the local cheeses while in the imported there was only one variety had a very low acidity being 0.87 % and another variety had a high acidity, 2.03 % while the other varieties ranged from 1.5-1.64 %.

Table (1) Chemical composition of processed cheeses available in the local market (average of 3 samples from every type).

Type of cheeses	pH	Acidity %	Total solids %	Fat		Lactose		Salt		Ash	
				Perse	DM	Perse	DM	Perse	DM	Perse	DM
Local											
Nesto Misr	6.07	1.45	44.38	12.67	28.53	9.87	22.25	1.75	3.95	6.20	13.97
Kirex	5.48	1.50	48.76	26.25	53.79	4.67	9.53	1.35	2.76	4.09	8.42
Siclam	6.25	1.20	44.92	15.75	35.05	3.47	7.72	2.13	4.78	6.14	13.71
Dolcy	6.00	1.40	43.59	21.33	48.94	1.23	2.82	1.38	3.16	4.84	11.11
El-Montazah	6.20	1.20	41.21	8.83	21.44	1.77	4.29	1.71	4.16	5.74	13.94
Min.	5.48	1.20	41.21	8.83	21.44	1.23	2.82	1.35	2.76	4.09	8.42
Max.	6.25	1.50	48.76	26.25	53.79	9.87	22.25	2.13	4.78	6.20	13.97
Mean	6.00	1.35	44.57	16.97	38.07	4.20	9.42	1.62	3.63	5.40	12.12
Imported											
La bonne Vache	5.97	1.50	45.90	23.00	50.42	6.27	13.69	1.27	2.76	4.29	9.36
Boy	5.93	1.50	42.51	24.83	58.43	4.50	10.59	1.36	3.20	4.08	9.60
Regal Picon	5.78	1.50	45.09	20.42	45.28	6.20	13.75	1.01	2.25	3.86	8.56
Maqubol	5.87	1.50	43.93	19.00	43.26	3.43	7.82	1.58	3.59	5.10	11.61
Kiri	5.83	0.87	50.93	34.17	67.09	1.85	3.63	0.79	1.56	2.61	5.11
Block	5.93	1.50	50.59	18.92	37.41	4.77	9.36	2.81	5.55	6.08	12.03
Three'Cow's	5.93	2.03	48.26	19.17	39.72	3.63	7.53	1.29	2.66	4.67	9.68
El-Ashbal	6.03	1.64	43.34	23.00	53.08	5.10	12.00	1.48	3.42	3.98	9.18
Min.	5.78	0.87	42.51	18.92	37.41	1.85	3.63	0.79	1.56	2.61	5.11
Max.	6.03	2.03	50.93	34.17	67.09	6.27	13.75	2.81	5.55	6.08	12.03
Mean	5.91	1.51	46.32	22.80	49.22	4.47	9.65	1.45	3.13	4.33	9.35

Total solids (T.S):

The total solids content of the analysed local cheeses ranged from 41.21 to 48.76 (Table 1). These values are less than the legal T.S of processed cheese and cheese foods namely: not less than 55 % (Egyptian legal standards, 1970). In the imported cheeses ranged from 42.51 to 50.93 %. We can consider the total solids of all varieties available in the local market fall in the range given for T.S in processed cheese spreads (40-50 %). The same results are given by Mahfouz et al (1986).

Fat:

The fat percentage (Table 1) of processed cheese available in the Egyptian markets varied widely from 21.44 to 67.09 per dry matter. Only two varieties from the local production (Kirex and Dolcy) fall within the legal standards, 1970 of processed cheese and cheese foods namely: not less than 40% . While, with imported cheeses all varieties lies within the Egyptian legal standards, 1970, except only one (Block) which was slightly below that of the standards (i.e. 37.41 % per dry matter). These results are within the vicinity of those obtained by Mahfouz et al (1986).

Lactose content:

Lactose content of the analysed of processed cheese varied widely where it recorded 2.822 to 22.25 per dry matter in local varieties and 3.633 to 13.751 per dry matter in the imported (Table 1). It was obvious that most of varieties ranged from 7.53 to 13.75 %, only one variety had 22.25 % per dry matter, while 3 varieties had 2.82 to 4.29 %. This may be due to that skimmilk or whey solids were probably one of the processed cheese

ingredients. The range of lactose content agreed with the corresponding values that found by Mahfouz et al. (1986).

Salt content:

The salt content falls within 2.76 - 4.78 % in the local cheeses while, it was from 1.56 to 5.55 % in the imported per dry matter (Table 1). The imported cheeses showed a great variation than the local processed cheeses. These variations in the salt contents can be deduced to the different ratios of salt in the ingredients from which it was made. However, all varieties lies within the Egyptian legal standards, 1970 (i.e. not more than 4 %) as it contained from 0.79 to 2.81 perse for all tested varieties.

Ash content:

Table (1) showed that the local processed cheeses ranged from 8.42 to 13.97 % per dry matter while in the imported cheeses, the ash content was lower than the local ones as it ranged from 5.12 to 12.03 % per dry matter. All brands examined lies within the Egyptian legal standards, 1970 (i.e. not more than 8%) as all of them fall within the range of 2.98 to 6.2 % perse.

Nitrogen distribution:

The total nitrogen in the analysed processed cheeses ranged from 2.307 to 2.632 % and 1.639 to 2.988 % in the local manufactured and imported processed cheese respectively. Expressed per dry matter they were 4.738 - 5.871 and 3.213 - 6.361 % in the same order. It was noticed that the samples which had minimum T.N content was characterized by high fat level (Table 2).

Table (2) Nitrogen fractions and total volatile fatty acids (TVFA) of processed cheeses available in the local market (average of 3 samples from every type).

Type of cheese	T.N Perse	T.N DM	S.N %	S.N/ T.N	N.P.N %	N.P.N/ T.N	Relative casein %	T.V.F.A 0.1 N ml. NaOH/100g
Local								
Nesto Misr	2.350	5.300	0.363	15.727	0.225	9.682	84.273	11.73
Kirex	2.305	4.738	0.372	16.233	0.221	10.748	83.626	7.35
Siclam	2.632	5.836	0.327	12.527	0.278	10.652	87.473	27.25
Dolcy	2.560	5.871	0.664	26.100	0.564	22.127	73.900	10.50
El-Montazah	2.315	5.616	0.237	10.239	0.191	8.237	89.761	32.00
Min.	2.305	4.738	0.237	10.239	0.191	8.237	73.900	7.35
Max.	2.632	5.616	0.664	26.100	0.564	22.127	89.761	32.00
Mean	2.430	5.450	0.393	16.170	0.296	12.181	83.830	17.77
Imported								
La bonne Vache	2.053	4.475	0.345	16.850	0.215	10.441	83.150	6.98
Boy	2.075	4.882	0.338	16.152	0.190	9.195	83.848	8.48
Regal Picon	1.967	4.358	0.240	12.217	0.191	9.740	87.783	11.20
Maqubol	2.794	6.361	0.637	22.749	0.569	20.360	77.251	19.00
Kiri	1.636	3.213	0.156	9.535	0.085	5.179	90.465	9.50
Block	2.988	5.911	0.390	13.047	0.261	8.743	86.953	11.30
Three'Cow's	2.310	4.662	0.763	34.234	0.632	28.347	65.765	34.67
El-Ashbal	1.969	4.515	0.285	14.450	0.220	11.168	85.550	8.25
Min.	1.639	3.213	0.156	13.047	0.085	5.179	65.760	6.98
Max.	2.988	6.361	0.763	34.234	0.632	28.347	90.465	34.67
Mean	2.214	4.780	0.394	17.796	0.294	13.279	82.204	13.68

Regarding the S.N content, the results (Table 2) cleard a wide variation especially in the imported varieties where it ranged from 0.156 to 0.763 while in the local types it ranged from 0.237 to 0.664 %. The S.N/T.N ratio with its wide variation among the tested brand suggest differences in the degree of ripening in the cheeses which was used in its manufacture.

The N.P.N showed also a wide variation among the different samples ranging from 0.191 to 0.564% in the local types and from 0.085 to 0.632 % in the imported cheeses(Table 2).The NPN constitute high percentage from the S.N of cheese. This may originated from the ingredient cheeses used or from the peptizing effect of emulsifying salts (Meyer, 1973).

The relative casein was ranged from 73.90 to 89.761 and 65.765 to 90.465 % in the local and imported cheeses successively(Table 2).

T.V.F.A:

Table (2) shows the great differences present in TVFA contents of the processed cheese in the Egyptian market. The majority were 6.98 to 11.7 ml 0.1 N NaOH/100g cheese, 2 samples (15.2 % of the total) contained 19.0 - 27.2 % and 2 samples (15.2 %) contained 32 - 34.67 ml. This wide variation is due to the differences in the ripening degree of the cheeses used in making processed cheeses.

Minerals:

Results in table (3) shows that the sodium content in analysed cheeses fall in narrow range of variation as it ranged from 0.92 to 1.80 and 0.60 to 1.68 % in local and imported

processed cheeses respectively. Phosphorus content in local processed cheese was higher than the phosphorus content in imported as it ranged from o.43 to 0.73% and from 0.13 to 0.60% successively. The calcium content of local cheeses appeared in a narrow range being 0.58 to 0.68 %, while, there was a wide variation in the imported variaties (0.22 - 0.64 %). This suggest that skimmilk and/or whey solids were probably added in the formula of processed cheeses. This was within the range given by Mahfouz et al.(1986). There was a wide range in potassium content as it ranged from 0.08 to 0.40 % and from 0.07 to 0.24 % in local and imported processed cheese respectively. The range of magnesium was from 0.08 to 0.11 % and 0.04 to 0.47 % in local and imported processed cheeses respectively. The manganese content was approximately the same in local and imported processed cheeses as it was ranged from 5 to 23 ppm and 6 to 22 ppm respectively.

Regarding the zinc content in local cheeses it was nearly the same being 21.5 to 25.5 ppm except one variety was very high where it recorded 111.5 ppm. Also in the imported cheeses, all samples ranged from 8.0 to 28.5 ppm except one variety recorded 76.5 ppm. The high level in some samples may be due to the materials of equipment used in the manufacture. These results agree with Harvey et al. (1982).

II- Physical Properties:

Melting index:

Table (4) shows some physical properties of the survayed samples. Expressing the melting test as a percentage, it was ranged from 17.26 to 124.44 and from 18.95 to 40.86 % in local and imported

Table (4) Some physical properties such as melting index and penetrometer reading of processed cheeses available in local market (average of 3 samples).

Type of cheese		Melting index %	Penetrometer 0.1 mm/sc.
Local			
Nesto		17.26	0.83
Kirex		73.65	0.44
Siclam		30.73	0.27
Dolcy		124.44	2.20
El-Montazah		30.89	0.37
	Min.	17.26	0.27
	Max.	124.44	2.20
	Mean	55.39	0.82
Imported			
Labonne Vache		28.29	1.91
Boy		40.86	2.16
Regal Picon		40.00	0.32
Maqubol		20.13	0.94
Kiri		28.06	0.40
Block		18.95	0.10
Three'Cows		21.81	1.49
El-Ashbal		31.37	2.00
	Min.	18.95	0.10
	Max.	40.86	2.16
	Mean	28.68	1.17

cheeses respectively. The majority of the samples (11 from 13) ranged from 17.26 to 40.86 %, only 2 samples from the local processed cheese were out of this range as they were 73.65 and 124.44%. The variation in melting of different varieties is due to the differences in ripening degree of the ingredients

Penetrometer reading:

The penetrometer reading indicates firmness of the processed cheese. In the local types it ranged from 0.27 to 0.83 (0.1 mm/sec). Only one sample gave high reading i.e. 2.2. This sample (Dolcy) was characterized with a high melting test and low relative casein and high degree of ripening in the ingredient cheeses which was confirmed by high soluble nitrogen content (Templeton and Sommer, 1934; Palmer and Sly, 1943 and Jakubowski and Bijok, 1959). The penetrometer reading of the imported cheeses ranged from 0.1 to 2.16 (0.1 mm/sec). This great variation can be attributed to differences in the ingredients.

Relationship Between Texture or Melting Properties and Some Chemical Parameters of Processed Cheese:

Table (5) points out the correlation coefficient (r) values between texture or melting properties with pH, acidity, fat, total solids, lactose and relative casein. The tabulated data clear that the determined texture of the tested cheese samples are highly correlated with pH values "r" = 0.9. In the second order came fat and relative casein where (r) was 0.6 and 0.55 sucessively, the total acidity "r" = 0.39 and total solids "r" = 0.4

Table (5) Relation ship between melting index and penetrometer reading and some chemical parameters of processed cheese in the local market.

Test	Melting index		Penetrometer reading	
	r	b	r	b
pH	0.20	-17.00	0.90	0.124
Acidity	0.01	-0.94	0.39	1.094
Fat	0.40	1.27	0.60	0.083
Total solids	0.16	-0.99	0.40	-0.085
Lactose	0.50	-4.50	0.20	-0.079
Relative casein	0.30	-0.91	0.55	-0.062

r = Correlation coefficient.

b = Regression cofficient.

correlate relatively weak with this property. The texture property was much less closely correlated lactose "r" = 0.2 which seems to be independent on this factor.

These results in fact are in agreement with Meyer (1973), where he reported the effect of pH variations in a range of 5.4, to 6.2. He found that an increase in pH value leads to better peptisation of casein which improved the body and produced thin viscosity. On the other hand the decrease in pH values, introduce a thickning and solidifying of the cheese structure. Jakubowski and Bijok (1960) found that a sharp change in the relationship between moisture and firmness of processed cheese occurred when moisture content increased above 55 %.

In respect of meltability of the tested processed cheese samples the corr-coefficient of this property was closely and positive correlated with lactose "r" = 0.5 and fat content "r" =0.4. The other factors were correlated at a lesser extend. The corr-coefficient value between total acidity and the melting of processed chees "r" = 0.01 is very low. This indicates that no relation exists between the total acidity and melting test of this type of cheese.

The obtained results dealing with the relationship between meltability and the chemical tested factors are in accordance with the results of Arnott et al. (1957), Rayan et al. (1980) and Harvey et al. (1982).

It can be concluded that melting and texture ratings which used as a major factors in judging processed cheese quality are depended mainly on pH, fat, and relative casein of processed cheese.

Further studies must be continued in this field to evaluate these two physical properties with different means of methods and instruments to stablish fixed relations between them and other available chemical determinations.

Microbiological analysis:

Tables 6 and 7 tabulated total bacterial counts, aerobic sporeformers and anaerobic sporeformers (proteolytic and saccharolytic) counts of the processed cheese brands.

The total viable counts of local brands ranged from 6.1 x 10^2 to 142 x 10^2 C.F.U/g while in the imported types were from 2.7 x 10^2 to 100 x 10^2 C.F.U/g . Generally, it can be seen from the two tables that the total bacterial counts were to some extent higher in the local types than in the imported where the mean average of them recorded 58.19 x 10^2 and 31.28 x 10^2 C.F.U/g cheese respectively.

The aerobic sporeformer counts ranged from 1.7 x 10^2 to 13 x 10^2 with an average of 5.1 x 10^2 C.F.U/g in local cheeses while it ranged from 1.5 x 10^2 and 13 x 10^2 with an average of 4.6 x 10^2 C.F.U/g in imported types. These results clears the counts of aerobic sporeformers in local and imported processed cheeses were nearly by the same.

Regarding the anaerobic sporeformers counts in the local and imported types, the proteolytic anaerobes ranged from 4.8 to 7.0 C.F.U and from 4.5 to 170 C.F.U/ g with an average 36.29 and 29.02 C.F.U/g respectively. In the case of saccharolytic anaerobic the counts were ranged from 0.0 to 33 C.F.U/g and 0.0 to 14 C.F.U/g with an average 9.74 to 3.28 C.F.U/g successively

Table (6) The bacterial counts of local processed cheeses.

Type of cheeses	Samples No.	Total counts x10^2	Aerobic spore formes x10^2	Anaerobic spore formes	
				Proteolytic	Saccharolytic
		C.F.U /G			
Nesto Misr	1	12.3	5.2	22.0	4.5
	2	6.1	3.0	22.0	8.0
	3	45.0	4.8	11.0	4.5
Kirex	1	44.0	1.7	11.0	8.0
	2	8.8	3.6	13.0	2.0
	3	108.0	2.3	4.8	4.5
Siclam	1	35.0	2.7	49.0	27.0
	2	8.0	3.6	49.0	33.0
	3	93.0	2.1	70.0	11.0
Dolcy	1	142.0	7.0	70.0	11.0
	2	100.0	1.8	49.0	0.0
	3	90.0	4.2	49.0	17.0
El-Montazah	1	88.0	13.0	49.0	6.8
	2	38.0	12.6	49.0	4.5
	3	65.0	9.0	27.0	4.5
	Mean	58.19	5.1	36.29	9.74

C.F.U = Colony forming unit.

Table (7) The bacterial counts of imported processed cheeses available in local market.

Type of cheeses	Samles No.	Total counts $x10^2$	Aerobic spore formes $x10^2$	Anaerobic spore formes Proteolytic	Anaerobic spore formes Saccharolytic
		C.F.U/g			
La bonne Vache	1	10.8	4.5	11.0	4.5
	2	5.0	2.6	17.0	0.0
	3	6.1	1.8	4.5	2.0
Boy	1	8.7	4.2	4.5	2.0
	2	5.2	2.6	11.0	0.0
	3	31.0	7.4	11.0	2.0
Regal Picon	1	34.0	5.3	22.0	4.5
	2	40.0	2.7	17.0	4.5
	3	52.0	4.5	17.0	2.0
Maqubol	1	51.0	2.9	17.0	2.0
	2	56.0	2.9	22.0	2.0
	3	45.0	4.2	14.0	4.0
Kiri	1	5.4	4.5	26.0	4.0
	2	2.7	1.5	14.0	0.0
	3	3.9	2.6	17.0	4.5
Block	1	50.0	3.7	11.0	14.0
	2	100.0	4.8	17.0	6.8
	3	65.0	4.0	70.0	11.0
Three'Cow's	1	46.0	13.0	22.0	2.0
	2	38.0	12.6	49.0	2.0
	3	65.0	9.0	27.0	2.0
El-Ashbal	1	4.8	2.9	4.5	0.0
	2	15.0	4.0	11.0	2.0
	3	10.0	3.5	8.0	1.0
	Mean	31.28	4.6	29.02	3.28

C.F.U = Colony forming unit.

These data, in fact, indicate that the counts of either proteolytic or saccharolytic anaerobes were mostly low. In spite of the presence of these counts the organoleptic evaluation revealed that these cheeses were in good conditions without any deleterious symptoms which confirm the suggestion that these spores were in dormant cause due to the unfavorable conditions after cooking and also to the unsuitable pH, moisture and salt contents (Barker, 1947 and Mladenove, 1972).

PART : II

PRELIMENARY STUDY TO PRODUCE PROCESSED CHEESE FROM DIFFERENT PROPORTIONS OF YOUNG AND MATURE CHEDDAR CHEESE.

Prelimenary Study to Produce Processed Cheese from different Proportions of Young and Mature Cheddar Cheese:

INTRODUCTION

In principle, processed cheese is made by mixing and heating the natural cheese with emulsifying agents and water. The kinds of cheese commonly processed included principally Cheddar and related American type cheeses and also Swiss, Brick and similar varities. The quality of the processed cheese is very largely determined by the quality of the raw cheese used. The selection of natural cheese for processing is determined chiefly by the age, acidity or pH, body, texture and composition of the cheese. However, the suitability of the raw material for a definite type of processed cheese depends on the state of ripening of the raw cheese. Cheese of different ages have various effects upon processed cheese.

Therefore, as Cheddar cheese is the most widely type used of raw material for processing throughout the whole world (Meyer, 1973); it was necessary to select the more suitable blend from young and mature Cheddar cheese which give a resultant processed cheese with good properties which considered as a control to the new proposed blends.

EXPERIMENTAL

This part was devoted to study the effect of different proportions of young and matured Cheddar cheese of 5 and 10

Table (8) Chemical analysis of used young and mature Cheddar cheese.

Type of cheeses	pH	T.S %	Fat (perse) %	F/DM %	Salt %
Young Cheddar cheese	5.2	63.81	32.1	50.31	1.96
Mature Cheddar cheese	5.4	65.01	33.2	51.07	1.66

Table (9) Amount of ingredients to form 20 Kg of processed cheese blends.

Ingedients	Amount of ingredients in Kg.		
	a	b	c
Young Cheddar cheese	12.20	8.10	4.03
Mature Cheddar cheese	4.07	8.10	12.09
Emulsifier salts	0.49	0.49	0.48
Salt (sodium chloride)	0.08	0.08	0.08
Water trial I	3.16	3.24	3.31
trial II	2.06	2.19	2.13

Samples from the manufactured process cheeses were analysed chemically, the physical properties were also investigated and then it was evaluated organoleptically.

RESULTS AND DISCUSSIONS

Table (10) clears the chemical analysis of the two prelimenary trials used for production of processed cheeses:

I- The first trial:

pH values:

It is obvious from the represented data in table (10) that the pH was 5.79, 5.50 and 5.45 in treatments a, b and c respectively. The results are in accordance with those given by many workers as it was stated that the final pH range required for the processed cheese is 5.4 to 5.9 (Meyer, 1973). Vakaleris et al (1962) reported that the defects in processed cheese could be overcome by adjusting the pH of the blend during processing to 5.4-5.5, which agree with our results.

Total solids:

Regarding the total solids in the same table it was 49.14, 51.08 and 50.44 % in a, b and c treatments respectively. There is no apparent difference between the treatments. The obtained results agree with Egyptian legal standards for

Table (10) Chemical and physical analysis of processed cheeses.

Determinations		First trial			Second trial		
		a	b	c	a_1	b_1	c_1
pH		5.79	5.50	5.45	5.35	5.36	5.38
Total solids	%	49.14	51.08	50.44	52.80	54.58	51.89
Fat (perse)	%	23.90	24.70	24.15	25.30	25.95	24.85
F/DM	%	48.64	48.35	47.88	47.91	47.54	47.88
Salt	%	1.67	1.77	1.74	1.73	1.84	1.82
Texture	g	89.70	96.70	103.70	289.00	222.00	176.70

a , a_1 = 75 % young + 25 % mature cheese.

b , b_1 = 50 % young + 50 % mature cheese.

c , c = 25 % young + 75 % mature cheese.

processed cheese which defined the total solids of processed cheese must be not less than 50 %.

Fat content:

In respect of fat content table (10) shows that it was 23.9, 24.7 and 24.15 % for a, b and c treatments respectively. Expressed the fat percent as F/DM, it was 48.64, 48.35 and 47.88 % in the same order. These figures lies within the Egyptian legal standards (1970) of processed cheese which emphasize that F/DM ratio must be not less 45 %.

Salt content:

The salt content of the produced processed cheese was 1.67, 1.77 and 1.74 % in treatments a, b and c respectively. This was achieved from the salt content of Cheddar cheese and used for preparing the blends, in addition to 0.5 % salt added to the blends' mixture. It is clear that there was no apparent differences occurred between treatments and all of them are lies within the Egyptian legal standards, 1970 (not more than 4 %).

Texture:

Texture of processed cheese considered the important physical property. The texture of the manufactured processed cheese in the different treatments was evaluated by "Stevens

LFRA texture". These results are recorded in table (10) and illustrated in fig (11). They were 89.3, 96.7 and 103.7 g in a, b and c treatments respectively.

II- The second trial:

This trial was investigated for the same chemical and physical parameters in the first trial (Table 10). It can be noticed that there are some differences between the values in this trial compared with the first one. These differences may be related to the water content in the blends of this trial as it was lowered by 10-15 % than the first one which induced reduction in the pH values to be about 5.36 in the three treatments.

The total solids showed an increase in this trial through the three treatments being 52.80, 54.58 and 51.89 % respectively for a_1, b_1 and c_1 treatments.

Dealing with the fat percentage it can be observed that it was higher than the first trial showing 25.30, 25.95 and 24.85 % in the same order.

The F/DM was almost the same being 47.91, 47.56 and 47.88 % in the three treatments. It is clear that there were no observed differences between the F/DM in the two trials as lowering the water content of the blends had no effect on this value.

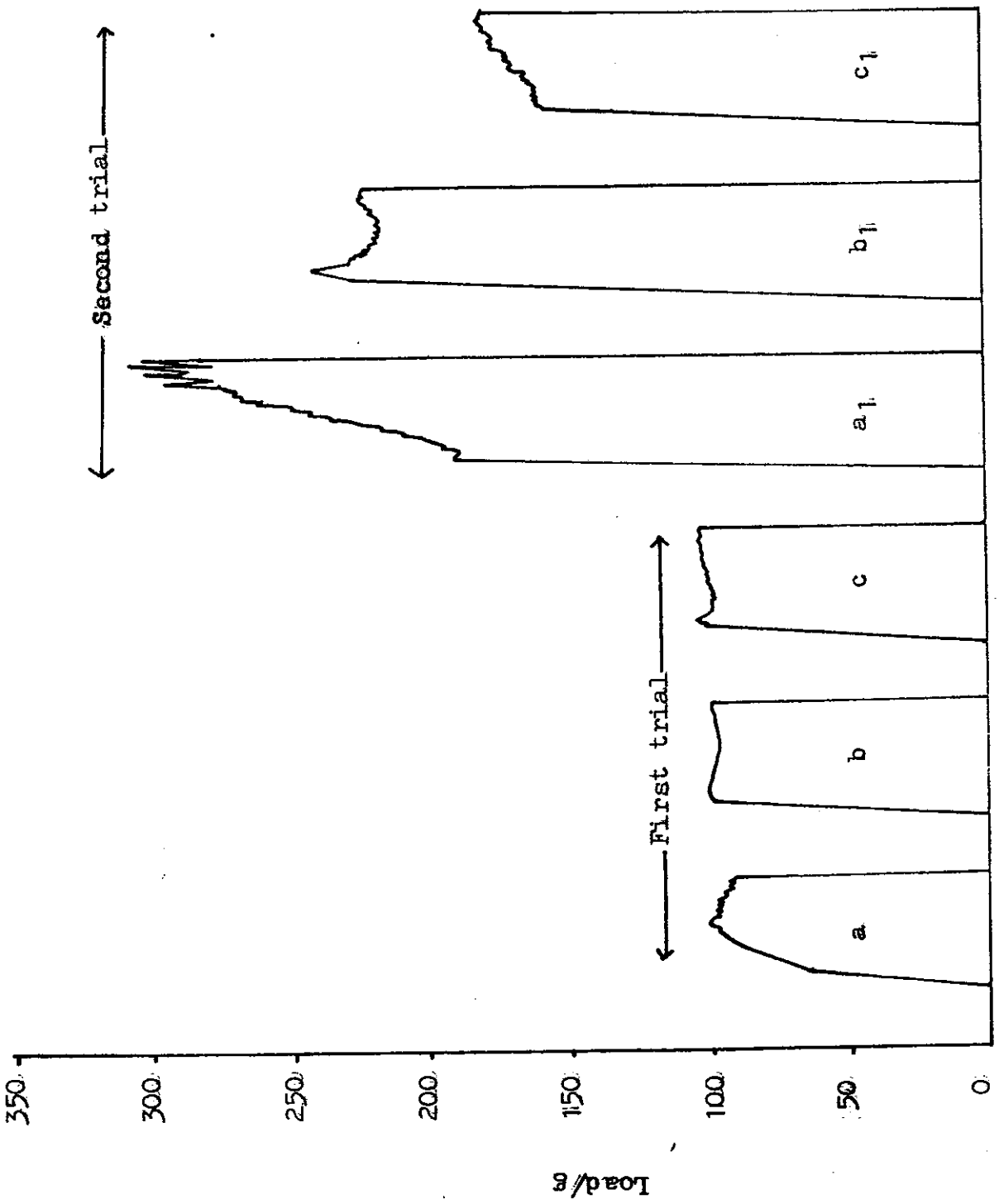


Fig (11) Texture consistency of prelimenary trials of processed cheese by using (Stevens LFRA analysis).

The salt content was 1.73, 1.84 and 1.82 % in a_1, b_1 and c_1 respectively which was somewhat higher, compared with the results in the first trial.

The texture of processed cheeses manufactured in the second trial were evaluated using "Steven LFRA Texture Analyser". It gave the following values 289.0, 222.0 and 176.7 g. Comparing these values with the values of the first trial, it can be noticed a great differences. These differences may be due to the reduction of pH which induced more firmness of the obtained processed cheese. In addition, these higher values can also be deduced to the higher percentage of total solids in the second trial than in the first one.

Organoleptic evaluation:

The manufactured processed cheese from different treatments of the two trials were evaluated organoleptically. The obtained data are presented in table (11) and illustrated in fig (12). It can be noticed that the processed cheeses manufactured in the second trial from blend mixture which con contains 25 % young + 75 % mature Cheddar cheese (treatment c_1) obtained the highest score points reaching 15.4, then come in the second order treatment (a_1) of the same trial which consists consists of 75 % young + 25 % mature Cheddar cheese with 14.4 points, while treatment (c) in the first trial come in the third order with 13.5 points. The processed cheese from

Table (11) The organoleptic evaluation of prelimenary trials of processed cheeses.

Roots of Scoring	Score	First trial			Second trial		
		a	b	c	a_1	b_1	c_1
Appearance	4	3.0	2.0	3.1	3.3	2.9	3.4
Texture	8	4.5	4.0	5.6	5.7	4.8	5.7
Flavour	8	3.7	3.4	4.8	5.4	2.7	6.3
Overall	20	11.2	9.4	13.5	14.4	10.4	15.4

a, a_1 = 75 % young + 25 % mature cheese.

b, b_1 = 50 % young + 50 % mature cheese.

c, c_1 = 25 % young + 75 % mature cheese.

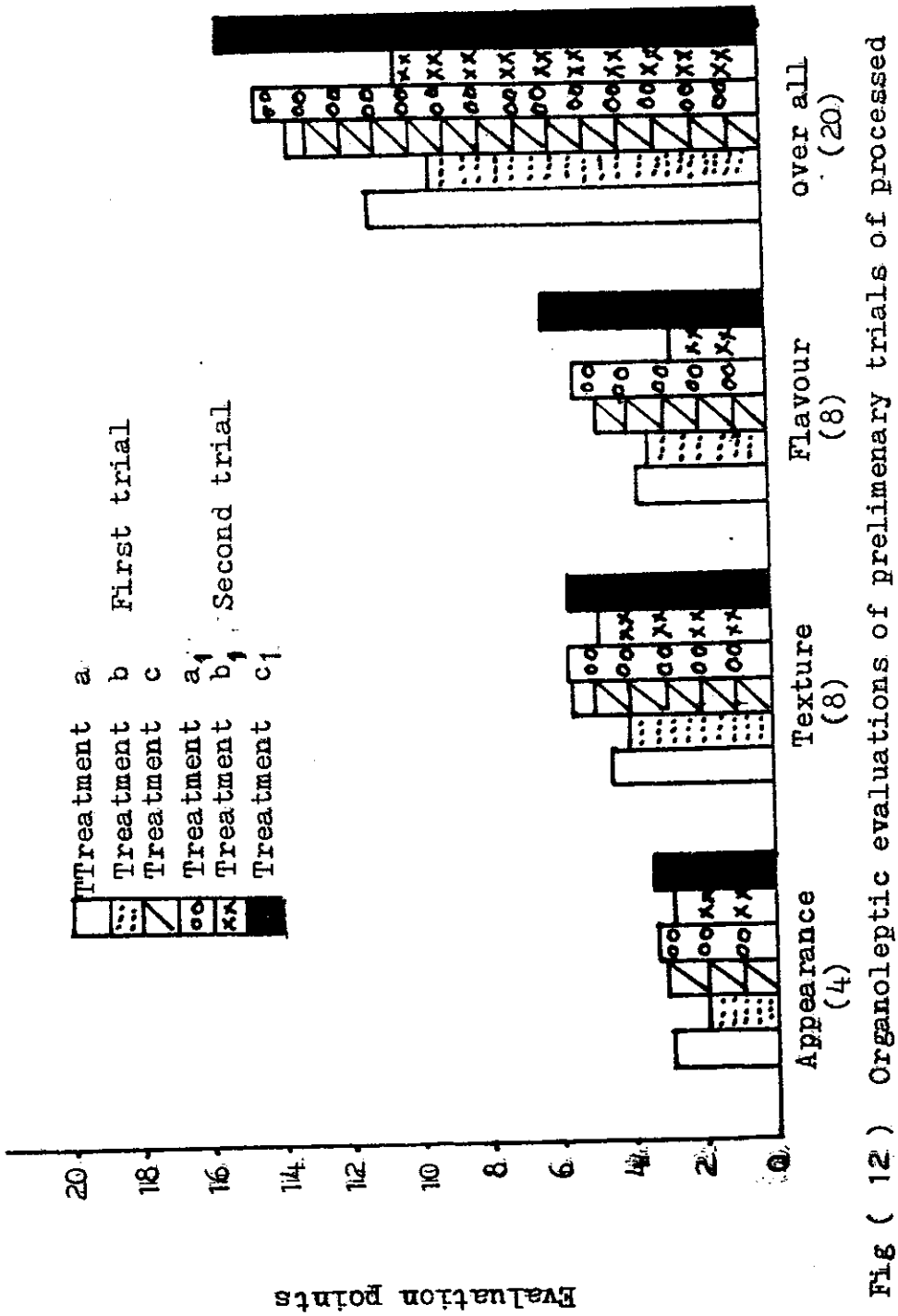


Fig (12) Organoleptic evaluations of prelimenary trials of processed cheese.

treatment (a) in the first trial and (b_1) in the second trial obtained lower points reaching 11.2 and 10.4 respectively. The processed cheese from treatment (b) in the first trial was gained the lowest points (9.4).

Depending on the organoleptic evaluation for processed cheeses manufactured by the different treatments of the two trials. It was noticed that from the blend containing 25 % young + 75 % mature Cheddar cheese through the second trial (treatment c_1) obtained the higher score points, followed by treatment (a_1) from the same trial which contained 75 % young + 25 % mature Cheddar cheese. According to the economic costs as a point of view the treatment (a_1) was selected to be as a control. This related to that the prefered treatment contains only 25 % mature Cheddar cheese which ripened for 10 months to reach the suitable degree of ripening while in the other treatment (c_1) which obtained somewhat high score points, ripened Cheddar cheese of 10 months old was 75 % which induce high costs.

PART : III

THE USE OF CHEESE-BASE IN THE MANUFACTURE OF PROCESSED CHEESE

The Use of Cheese-Base in The Manufacture of Processed Cheese:

INTRODUCTION

The particular application of ultrafiltration technology to the treatment of milk for making cheese with a substantially improved yield was carried in a French patent in 1969 by Maubois et al. The main application of their work was for the production of Camembert and other high-moisture cheese varieties. Ultrafiltration of milk for Cheddar cheese has been attempted, but a major problem has been lack of a suitable method for raising the protein content of the precheese to the level required in the final product. In 1980, Ernstrom et al. described a cheese-like product-cheese base and a production method for the same. This process now has been adapted to the dairy industry's needs.

Cheese-base is intended as a raw product for the processed cheese industry and must therefore, in the chemical respect fulfill the same demands as are made for Cheddar cheese.

Our objective was to develop a method for the direct manufacture of a high yielding low moisture process cheese-base by the application of ultrafiltration, which may replace Cheddar cheese in the case of processed cheese.

SECTION A

Production of Cheese-Base Based on Ultrafiltration:

EXPERIMENTAL

Reconstituted skimmilk powder, 20 % (RSMP) was ultrafiltrated followed by diafiltration to exclude partially the lactose and increase the protein content by using ultrafiltration

DDS unit. The obtained retentate was pasteurized at 72°C for 15 S and immediately cooled to 10°C. On the second day the pasteurized retentate was warmed to 32°C, inoculated with 0.2 g dried cheese starter/Kg retentate and then incubated at the same temperature to reach pH 5.8 ± 0.1. Rennet solution was added with a level of 0.25 ml/kg retentate and pumped to "Alcurd" machine where remained for 7 to 9 minutes till complete coagulation. The coagulum pushed through Alcurd machine in order to get regular cubes then stirred manually for 15 min till pH 5.6. The temperature raised gradually from 32°C to 39°C during 10 min. and the resultant whey was drained. The obtained curd divided into two portions, one was salted at level of 2.5 % with dry sodium chloride, while the other part was treated with proteolytic enzym (Savorase-A) with a level of 16.2 - 16.5 g./kg curd. The salt content of this part was adjusted to the same level of the first part considering the amount of salt associated with the added enzyme. The obtained curd with and without proteolytic enzyme were moulded in rectangular metal and pressed overnight using air pressure to remove the excess whey in the curd. The pressed curd "cheese base" was then packed in polyethelene bags containers (18 kg) and sealed under vaccum. The cheese base without enzyme was named "cheese base I" and the other with enzyme was named "cheese base II".

The young cheddar cheese, mature cheddar cheese, fresh cheese base I and fresh cheese base II were analysed chemically for pH, total solids, proteins, salt, ash, lactose, calcium and phosphorus. Microbiological determinations were carried out for

total counts, yeasts and moulds, coliform, aerobic sporeformers and anaerobic sporeformers (Saccharolytic and proteolytic).

The cheese base I and II were stored at 10°C for 2 weeks, where S.N, glycine and gel-electrophoresis were carried out to follow the variations in the protein degradation during the storage period of the cheese base I and II at intervals of 0, 1 and 2 weeks.

RESULT AND DISCUSSIONS

Composition of Cheese-Base I and Cheese-Base II Compared with Cheddar Cheese, and The Different Products During Preparing The Cheese Base:

Chemical analysis:

Table (12) clears the chemical analysis of Cheddar cheese and the different products during preparing cheese base I and cheese base II. The young Cheddar cheese analysis (5 months ripening period) cleared the following: pH 5.28 total solids 66.3 %, fat 33.64 %, salt content 1.72 %, protein 25.02 %, ash 4.05 %, lactose 4.6 %, calcium 0.78, and phosphorus 0.66 %. On the other hand, the mature Cheddar cheese (10 months old) showed an increase in salt, protein, fat % as well as a slight decrease in pH value, T.S and lactose while it was nearly constant in calcium, phosphorus and ash content. The obtained results comply with the UK standards for Cheddar cheese of a minimum 50 % F/DM and 39 % as a maximum for water content as mentioned by Ernstrøm et al. (1980) and Madsen and Bjerre (1981).

Table (12) Composition of cheese-base I and cheese-base II compared with Cheddar cheese, and the different products during preparing the cheese base.

Products	pH	Total solids %	Salt		Protein		Ash %	Lactose		Calcium %	Phosphorus %	Fat	
			Perse	DM	Perse	DM		Perse	DM			Perse	DM
Yong cheddar cheese	5.28	66.31	1.72	2.59	25.02	37.79	4.05	4.06	6.12	0.78	0.66	33.64	50.73
Mature cheddar cheese	5.27	65.26	1.95	2.99	25.52	39.11	4.03	2.64	4.04	0.82	0.64	33.26	50.96
Reconstituted skim milk powder	-	19.78	-	-	7.44	37.61	1.57	10.77	54.65	-	-	-	-
1 st permeate	-	12.97	-	-	0.59	4.55	1.01	11.38	87.73	-	-	-	-
2 nd permeate	-	6.48	-	-	0.34	5.25	0.54	5.56	85.79	-	-	-	-
Retentate	-	20.48	-	-	14.18	69.24	1.66	4.65	22.63	-	-	-	-
Whey after curd cutting	-	8.87	-	-	2.86	32.24	0.80	5.23	59.06	-	-	-	-
Fresh cheese base I	5.26	44.83	1.65	3.68	36.30	80.97	4.73	3.80	8.49	1.02	0.45	-	-
Fresh cheese base II	5.30	45.82	1.60	3.40	37.45	81.73	4.65	3.72	8.12	1.02	0.38	-	-

- Did not determined.

The RSMP (20 %) used for ultrafiltration showed 19.78 % T.S, 7.44 % protein, 1.57 % ash and 10.77 % lactose. The RSMP was ultrafiltrated and the first permeate gave 12.97 % T.S, 0.59 % protein, 1.01 % ash and 11.38 % lactose. The obtained retentate was diafiltrated to give second permeate of 6.48 % T.S, 0.34 % protein, 0.54 % ash and 5.56 % lactose. The final retentate contained 20.48 % T.S, 14.18 % protein, 1.66 % ash and 4.65 % lactose. The obtained results in respect to retentate protein content agrees with the results of Sood and Kosikowski(1979) and Madsen and Bjerre (1981).

The retentate was fermented by the addition of active dried starter, thereafter rennet was added then pushed through Alcurd to be coagulated and cutted to cubes. This curd was stirred for 10 min. followed by draining of the whey. The chemical analysis of this whey is presented in table (12) showing 8.87 % T.S, 2.86 % protein, 0.80 % ash and 5.23 % lactose.

Part of the obtained curd was put in rectangular metal mould and pressed overnight to give the fresh cheese base I. Cheese base II was manufactured by the same except that proteolytic enzyme was added to the other part of the curd before moulding. The chemical analysis of cheese base I was 44.83 % T.S, 1.65 % salt, 36.33 % protein, 4.73 % ash, 3.80 % lactose, 1.02 % calcium, 0.45 % phosphorus and it had a pH value of 5.26. On the other hand, the chemical analysis of the fresh cheese base II showed, 45.82 % T.S, 1.60 % salt, 37.45 % protein, 4.65 % ash, 3.72 lactose, 1.02 % calcium, 0.38 % phosphorus and it with pH of 5.3.

The obtained results in respect of cheese base cleared a great difference than that prepared by Madsen and Bjerre (1981) and Rubin and Bjerre (1983) from full cream and by another technique where the retentate was evaporated under vacuum at 43°C until a dry matter content of about 60 % was attained.

Degradation of protein:

Data presented in table (13 and 14) and fig (13) clear the protein degradation of cheese base I (without proteolytic enzyme) cheese base II (treated with proteolytic enzyme), young and mature Cheddar cheese. It is obvious that the soluble nitrogen and the amino acid glycine increased in cheese base I after the ripening period of two weeks at 10°C. The ripening process of cheese base II was much faster. This acceleration in ripening was attributed to the addition of the commercial proteolytic enzyme (Savorose-A) which lead to a high level of soluble nitrogen in cheese base II after one week of ripening period as it was 0.79 % The corresponding value of S.N in cheddar cheese with 5 months old was 0.69 %. After the second week of cheese base II ripening, the soluble nitrogen was about the same in mature Cheddar cheese (1.02 %) which ripened for 10 months.

The use of released amino acid glycine as an index for cheese flavour production (Imperial Bio. Tech. 1988) was adopted in this investigation. It gave a higher value of 250 µg/ml after only one week in cheese base II compared with (225 µg/ml) in Cheddar cheese of 5 months old. The glycine content was 490 µg/ml in mature Cheddar cheese (10 months) compared with 400 µg/ml in cheese base II after only 2 weeks.

Table (13) protein degradation in cheese base I and II during ripening period.

Products	Ripening period											
	Fresh				1 week				2 week			
	T.N %	S.N %	S.N/ T.N	Gly- cine µg/ml	T.N %	S.N %	S.N/ T.N	Gly- cine µg/ml	T.N %	S.N %	S.N/ T.N	Gly- cine µg/ml
Cheese base I	5.86	0.409	6.98	80	5.86	0.464	7.92	105	5.86	0.497	8.49	115
Cheese base II	5.87	0.564	9.61	155	5.87	0.787	13.40	250	5.87	1.063	18.12	400

Table (14) Protein degradation in young and mature Cheddar cheese.

Products	T.N %	S.N %	S.N/T.N	Glycine µg/ml
Young Cheddar cheese (5 months old)	3.92	0.694	17.52	255
Mature Cheddar cheese (10 months old)	4.00	1.021	25.52	490

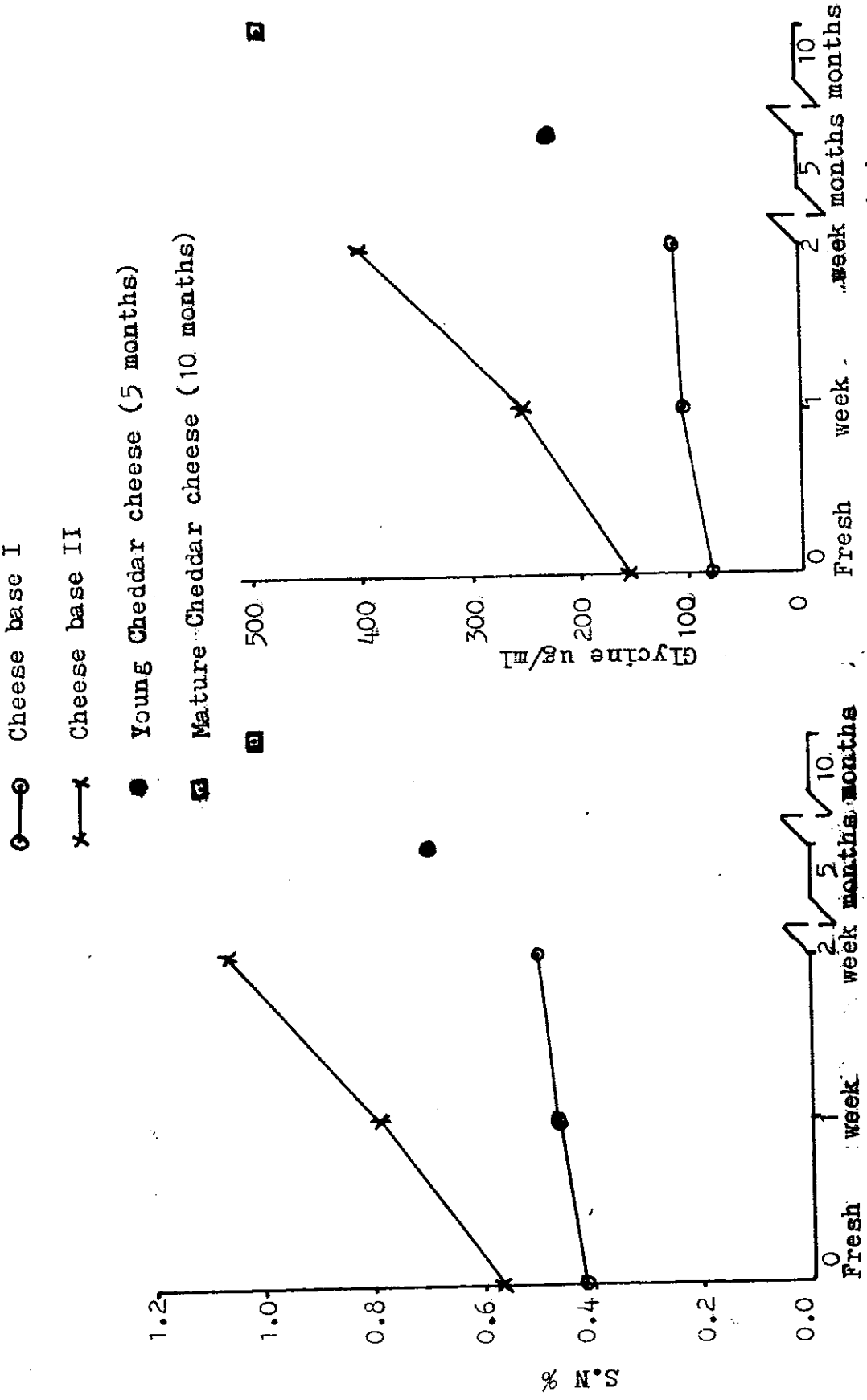


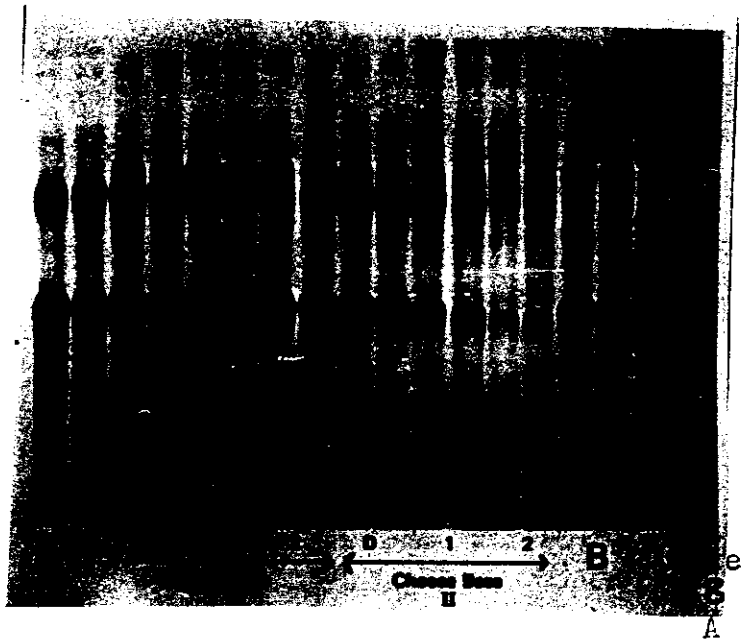
Fig. (13) S.N and glycine in young and mature Cheddar cheese and cheese base I and II during ripening period.

Depending on the tested ripening indices of Cheddar cheese, the prepared cheese like (cheese base II) after 2 weeks ripening can replace the mature cheddar cheese in processed cheese manufacture. The introduction of this new prepared product has economical advantages since there is no need for the long period of cheese ripening. In addition, a considerable amount of milk proteins saving as a result of using ultrafiltration technique by about 18 - 20 % as reported by Madsen and Bjerre (1981). Also, they reported that the use of cheese base in replacing either young or mature Cheddar cheese for processed cheese manufacture may reveal the following :-

a) A constant and consistent chemical composition of final product.
b) Reduced product lose.
c) Continuous product flow.

Electrophoretic Pattern of Cheese Base and Cheddar Cheese Proteins:

The results obtained from protein degradation in Cheddar cheese and cheese base indicated that a considerable proteolysis occurred during ripening. Fig (14) shows the changes in the electrophoretic pattern of the brevious products. In cheese base I (without enzyme) the electrophoretic pattern of protein showed the presence of β and α_s-casein as the major protein fraction when fresh and after 1 and 2 weeks of ripening period compared with the sodium caseinate as a standard. Regrading cheese base II treated with "Savorase-A enzyme" the fresh product indicates the same bands as in cheese base I. During the ripening period the electrophoretic pattern of protein was characterized by the



Fast moving fraction

α-casein
β-lactoglobulin
β-casein

Slow moving fraction

Type

Sodium caseinate

Cheese base I:

Fresh	0
1 week storage period	1
2 week storage period	2

Cheese base II:

Fresh	0
1 week storage period	1
2 week storage period	2

Young Cheddar cheese B

Mature Cheddar cheese C

Fig. (14) Electrophoretic pattern of cheese base and Cheddar cheese.

presence of several bands of slow mobilities, the bands of β-casein. This intensity of the bands with the lowest mobility suggest the major degradation components in cheese base II.

The electrophoretic pattern was also characterized by several small bands of mobilities in between of β and α_s-s casein and with mobilities higher than β-casein. These increased bands are related to the degradation of α-s_1 casein. It is clear that the changes in electrophoretic pattern of cheese base II during further ripening (1 and 2 weeks) were quantitative and qualitative as illustrated in fig (14). The electrophoretic pattern of cheese base I and II showed a small band of β-lactoglobulin existed between α and B-casein. The presence of β-lactoglobulin in UF-cheese base is mainly due to the enclosure of whey proteins present in the retentate. This band was reported by many workers (De Koning, 1980; El-Shabrawy, 1985 and Abdou et al, 1988).

The intensities of αs_1, β_1-casein and β-lactoglobulin bands were gradually decreased after the second week of the ripening period. The present results are in a good agreement with that indicated by Ridha (1984) on the electrophoretic studies of the accelaration of Cheddar cheese ripening by using proteolytic enzymes.

In respect of the electrophoretic pattern of young and mature Cheddar cheese, it is obvious that the young Cheddar cheese (5 months old) showed several bands of slow mobilities and several other bands of faster mobility than β-casein. In addition there are many bands of more higher mobilities than

α-s casein. These bands increased qualitatively and decreased in intensities in the mature Cheddar cheese (10 months) compared with young Cheddar cheese.

Microbiological analyses:

Data in table (15) represented the microbiological analyses of the pasteurized retentate, cheese base I, cheese base II, young and mature Cheddar cheese. The total bacterial counts of the previous products showed $5.2x10^2$, $113x10^8$, $195x10^8$, $42.7x10^6$ and $2.86x10^6$ C.F.U/g respectively. The yeasts and moulds counted 10, 18, 25, 10 and 10 C.F.U/g. for the same products in the same order. The aerobic sporeformers for the tested products were $8.4x10^2$, $3.7x10^2$, $3.25x10^2$, $19x10^2$ and 85 C.F.U./g. successively.

Regarding the anaerobic sporeformers, it was noticed that they were absent from the tested products except in the pasteurized retentate and young Cheddar cheese as they were 15 and 40 C.F.U/g for the saccharolytic bacteria respectively. The coliform group of bacteria were absent in all the tested products.

Table (15) Microbiological analyses of pasteurized retentate, cheese base I, cheese base II, young and mature Cheddar cheese.

Products	Coliform	Total count	Yeast and mould	Aerobic spore-formers	Anaerobic sporeformers Saccharo-lytic	Anaerobic sporeformers Proteo-lytic
	C.F.U					
Pasteurized retentate	N.D	$52.0x10^2$	10	$8.40x10^2$	15	N.D
Cheese base I	N.D	$113.0x10^8$	18	$3.70x10^2$	N.D	N.D
Cheese base II	N.D	$195.0x10^8$	25	$3.55x10^2$	N.D	N.D
Young Cheddar cheese	N.D	$42.7x10^6$	10	$19.00x10^2$	40	N.D
Mature Cheddar cheese	N.D	$28.6x10^6$	10	85.00	N.D	N.D

C.F.U = Colony forming unit.

N.D = Not detected.

SECTION: B

Manufacture of Processed Cheese by Using The Cheese-base As A Raw Material to Replace Cheddar Cheese:

Experimental

Table (16) shows the replacement of natural Cheddar cheese (young and mature) by using cheese base I and II which were prepared from reconstituted skimmilk powder (20 %) by using ultrafiltration to reduce the lactose content in retentate.

Table (17) ilustrates the amount of ingredients used to form 14 kg of different blends for manufacture block processed cheese. The storageability of the obtained processed cheese was studied under different temperatures 10^{o}, 20^{o} and $30^{o}C$ for 6 months. Samples were taken periodically when fresh, 3 and 6 months of storage.

The samples were analysed chemically for total solids, fat, pH, salt, ash, total nitrogen, soluble nitrogen and lactose. Also microbiologically for total count, yeasts and moulds, aerobic and anaerobic sporeformers and detection for coliform group.

The physical properties were evaluated by measuring oil separation, melting index, penetrometer reading, texture, hardness, cohesiveness, gumminess, springing, adheseviness and optical density of colour during the storage period at different temperatures previously mentioned.

The organoleptic properties were tested by score panels of 10 persons from the staff of Food Sci. Dept. at West of Scotland College Auchincruive Ayr, for only samples of processed cheese stored at $10^{o}C$.

RESULTS AND DISCUSSIONS

I. Chemical Composition of Processed Cheese:

1) Total solids (T.S):

Table (18) indicates the percentage of total solids of processed cheese made from different blends during storage at different temperatures. The total solids of the fresh processed cheese in the control and different treatments ranged from 50.34 to 52.45 % with an average of 51.14 %. This uniformity in total solids content in all cheeses may be due to the correction of moisture content of the blends to guarantee the level of Egyptian legal standards (not less than 50 %). The values of total solids showed a slight increase during the storage period (6 months) at variable temperatures.

Table (19) shows the interaction of total solids means between storage temperature and storage time of processed cheese from different blends. This table explained that the total solids increased by prolonging the storage period or by increasing the storage temperature, which may be attributed to the lost of moisture during the storage period. This was explained by the report of "DRG Flexable Packaging" which cleared that the moisture vapour transmission rate was 0.8 up to 1 gm/M^2/24 hrs at 25°C and 75 % RH for the "Pukkafilm" pouches.

Table (20) represents the analysis of variance (F. test) for total solids of the processed cheese made from different blends. It can be noticed that the differences between treatment x storage time, are insignificant while they were highly significant between treatments, storage time and storage time x storage temperature.

Table (18) Total solids of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Fresh	Storage period: 3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
		%									
Control	50.34	50.53	50.90	50.84	50.76	50.79	51.60	51.67	51.35	50.95	0.505
Using cheese base I:											
A	50.56	50.21	50.40	50.66	50.42	50.61	50.95	51.24	50.94	50.66	0.345
B	51.85	51.64	51.77	51.72	51.72	51.72	52.26	52.58	52.19	51.85	0.437
C	52.17	52.69	52.49	52.85	52.68	52.50	53.14	53.38	53.01	52.75	0.414
D	52.45	52.89	52.83	53.45	53.06	52.68	53.06	53.59	52.78	52.85	0.537
E	50.73	50.84	51.62	51.39	51.28	50.84	51.77	51.40	51.34	51.23	0.419
F	52.33	52.32	52.31	52.38	52.34	52.41	52.67	52.79	52.63	52.46	0.193
Using cheese base II:											
A_1	50.84	50.13	50.38	50.86	50.46	50.36	50.73	52.00	51.03	50.76	0.616
B_1	51.23	51.83	51.74	52.03	51.87	52.20	52.02	52.35	52.36	51.99	0.465
C_1	50.53	50.15	50.23	50.42	50.27	50.05	50.23	51.02	50.43	50.38	0.324
D_1	50.83	50.93	51.26	51.36	51.18	51.46	51.54	51.89	51.63	51.32	0.364
E_1	51.73	52.07	52.24	52.62	52.31	52.00	52.91	53.09	52.67	52.38	0.505
F_1	50.26	50.40	50.77	50.69	50.62	50.50	50.75	51.35	50.87	50.67	0.353
Experimental control	50.75	51.87	51.53	51.68	51.69	51.58	51.88	52.37	51.94	51.67	0.492
Means	51.14	51.32	51.46	51.64	51.47	51.44	51.75	52.20	51.80	51.52	—

Table (19) Interaction of total solid means between storage temperatures and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Mean	S.D
Fresh	51.143	-	-	-	51.143	0.774
3 months	-	51.322	51.462	51.638	51.474	0.902
6 months	-	51.443	51.750	52.196	51.796	0.904
Means	51.143	51.383	51.606	51.912	51.565	--
S.D	0.744	0.934	0.846	0.904	--	--

S.D = Standard deviation.

Table (20) Analysis of variance (F-test) for total solids of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.R	Sign.
Treatment	13	62.9855	4.8450	66.79	**
Storage time	2	5.0947	2.5474	35.12	**
Storage time x storage temp.	4	4.7166	1.1792	16.26	**
Treatment x storage time	26	2.5636	0.0986	1.36	n.f
Residual	52	3.7721	0.0725		
Total	97	79.1325			

d.f = degree of freedom.
S.S = Sum squre.
M.S = Mean squre.
Sign. = significant.
* = Significant.
n.f = insignificant.
** = Highly significant.

However, the total solids of the obtained processed cheeses either fresh or after storage lies within the Egyptian and UK legal standards for this product.

2) Fat content:

Data in table (21) clears the percentage of F/DM of processed cheese obtained from different blends when fresh and after 3 and 6 months storage period at 10°, 20° and 30°C. This obtained values ranged from 47.69 to 48.69 with an average of 48.13 % for fresh samples. The results revealed no obvious differences as the fat content of the blends was standardized by adding anhydrous milk fat to obtain processed cheese with approximately 48 % to comply the Egyptian legal standards.

The interaction of F/DM during storage time at different temperatures for the obtained processed cheese are shown in table (22) . It is obvious that a sligh increase was occurred between fresh, 3 and 6 months' old. The same trend can be observed during storage at different temperatures.

Table (23) showed that there were highly significant results between treatments, storage time and storage time x storage temperature but it was only significant in the connection between treatment and storage time.

3) pH values:

Data presented in table (24) for values clears that it was ranged from 5.41 to 5.66 with an average of 5.55 for the fresh samples. The differences between the treatments were undetectable because the pH of all processed cheeses was adjusted to be 5.4-5.7

Table (21) F/DM of processed cheese from different blends during storage period at different temperatures and mean values.

Blends	Fresh	Storage period: 3 months 10°C	3 months 20°C	3 months 30°C	3 months Means	6 months 10°C	6 months 20°C	6 months 30°C	6 months Means	Means	S.D
		%									
Control	48.57	48.29	49.01	49.67	48.99	48.53	48.84	49.64	49.00	48.94	0.543
Using cheese base I:											
A	47.76	48.29	48.41	48.76	48.49	48.02	47.99	48.69	48.23	48.23	0.323
B	47.81	47.93	48.10	48.24	48.09	47.66	48.22	47.93	47.94	47.98	0.214
C	48.30	48.02	48.67	48.92	48.54	48.63	48.46	48.80	48.63	48.54	0.309
D	48.62	48.02	47.80	48.64	48.16	48.88	48.99	49.07	48.98	48.57	0.489
E	48.69	49.18	49.40	49.66	49.42	48.78	48.58	49.13	48.83	49.06	0.398
F	47.77	47.98	48.37	49.26	48.53	48.84	48.22	48.78	48.61	48.46	0.524
Using cheese base II:											
A_1	47.80	49.47	49.62	49.15	49.41	49.55	49.87	48.74	49.39	49.17	0.707
B_1	47.92	48.33	48.03	48.05	48.14	47.72	48.93	48.61	48.42	48.23	0.422
C_1	48.19	48.35	48.38	48.79	48.51	49.45	49.66	49.30	49.47	48.88	0.595
D_1	48.00	49.19	49.36	48.87	49.14	49.26	48.90	48.95	49.04	48.93	0.451
E_1	48.24	48.01	48.33	48.46	48.27	47.92	47.63	48.50	48.02	48.16	0.318
F_1	48.45	48.01	49.25	49.32	48.86	49.01	49.56	48.98	49.18	49.94	0.536
Experimental control	47.69	47.42	47.64	48.38	47.81	48.57	47.90	48.60	48.36	48.03	0.480
Means	48.13	48.32	48.60	48.87	48.60	48.63	48.70	48.36	48.72	48.58	--

Table (22) Interaction of F/DM means between storage temperatures and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Mean	S.D
Fresh	48.128	-	-	-	48.128	0.354
3 months	-	48.321	48.598	48.869	48.596	0.601
6 months	-	48.630	48.695	48.360	48.720	0.570
Mean	48.129	48.475	48.646	48.853	48.582	-
S.D	0.354	0.601	0.648	0.446	--	--

Table (23) Analysis of variance (F-test) for fat of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.R	Sign.
Treatment	13	14.8488	1.1422	8.87	**
Storage time	2	3.6898	1.8449	14.32	**
Storage time x storage temp.	4	2.4157	0.6039	4.69	**
Treatment x storage time	26	5.7917	0.2227	1.73	*
Residual	52	6.6992	0.1288		
Total	97	33.4449			

Table (24) The pH values of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period: Fresh	3 months: 10°C	3 months: 20°C	3 months: 30°C	3 months: Means	6 months: 10°C	6 months: 20°C	6 months: 30°C	6 months: Means	Means	S.D
Control	5.60	5.40	5.40	5.40	5.40	5.30	5.26	5.27	5.28	5.38	0.117
Using cheese base I:											
A	5.52	5.30	5.30	5.35	5.32	5.28	5.32	5.28	5.29	5.34	0.085
B	5.55	5.40	5.30	5.35	5.35	5.27	5.25	5.29	5.27	5.34	0.104
C	5.66	5.40	5.40	5.40	5.40	5.34	5.37	5.28	5.33	5.41	0.120
D	5.61	5.40	5.40	5.40	5.40	5.30	5.26	5.22	5.26	5.37	0.130
E	5.61	5.50	5.50	5.50	5.50	5.32	5.31	5.28	5.30	5.43	0.127
F	5.59	5.40	5.40	5.40	5.40	5.29	5.25	5.26	5.27	5.37	0.119
Using cheese base II:											
A_1	5.41	5.30	5.30	5.30	5.30	5.18	5.28	5.22	5.23	5.28	0.073
B_1	5.41	5.30	5.30	5.30	5.30	5.20	5.32	5.27	5.26	5.30	0.062
C_1	5.60	5.30	5.30	5.30	5.30	5.29	5.35	5.30	5.31	5.35	0.113
D_1	5.47	5.30	5.40	5.30	5.33	5.29	5.33	5.29	5.30	5.34	0.069
E_1	5.54	5.30	5.40	5.30	5.33	5.37	5.38	5.36	5.37	5.38	0.081
F_1	5.62	55.35	5.40	5.40	5.38	5.35	5.41	5.38	5.38	5.42	0.093
Experimental control	5.54	5.30	5.40	5.40	5.36	5.30	5.34	5.36	5.33	5.38	0.083
Means	5.55	5.35	5.37	5.36	5.36	5.29	5.32	5.29	5.30	5.36	--

during processing by selecting the suitable mixture of John emulsifying salts that achieved this pH range. Thus, the range of pH in fresh obtained cheeses are lies within the best range that suggested by Meyer (1973), Thomas (1977) and Sood and Kosikowski (1979).

Moreover, the pH value in all cheeses decreased during storage at the different temperatures to fall in a narrow pH range of 5.3 to 5.5 after 3 months storage and continued with a very slow rate of decrease to be 5.2 to 5.5 after 6 months storage at different temperatures (Table 25).

It could be concluded from the above results that manufacture of processed cheese from different ingredients had no practical significant effect on the pH of the resultant cheese, thus agreed with Gouda (1980).

Table (26) for F-test cleared that the variance was highly significant between treatments, storage time and storage time x treatment while storage time x storage temperature showed no significance.

4) Salt content:

Table (27) shows the percentage of salt content of fresh processed cheese made from different blends and the effect of storage. It was found that the salt content in fresh cheese ranged from 1.31 to 1.66 with an average of 1.54 %. It was reported that the salt content of processed cheese is proportional to the amount of Cheddar cheese in the blend. The cheese made fully from Cheddar cheese contained the maximum percentage of salt (1.66 %), while the cheese made only fron cheese base without Cheddar cheese contained the lowest percentage (1.31 %). Generally, the salt

Table (25) Interaction of pH value : means between storage temperatures and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Mean	S.D
Fresh	5.55	-	-	-	5.55	0.0772
3 months	-	5.35	5.37	5.36	5.36	0.0605
6 months	-	5.79	5.32	5.29	5.29	0.0505
Mean	5.55	5.32	5.34	5.33	5.36	--
S.D	0.0772	0.0672	0.062	0.0654	--	--

Table (26) Analysis of variance (F-test) for pH value of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	0.1548	0.0119	12.12	**
Storage time	2	0.6713	0.3357	341.68	**
Storage time x storage temp.	4	0.0084	0.0021	2.15	n.f
Treatment x storage time	26	0.1179	0.0045	4.62	**
Residual	52	0.0511	0.0010		
Total	97	1.0036			

Table (27) Salt content of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Fresh	Storage period: 3 months 10°C	3 months 20°C	3 months 30°C	3 months Means	6 months 10°C	6 months 20°C	6 months 30°C	6 months Means	Means	S.D
		%									
Control	1.66	1.76	1.77	1.68	1.74	1.79	1.78	1.81	1.79	1.75	0.057
Using cheese base I:											
A	1.34	1.44	1.45	1.47	1.45	1.48	1.49	1.50	1.49	1.45	0.053
B	1.54	1.64	1.61	1.46	1.63	1.62	1.81	1.68	1.70	1.65	0.081
C	1.63	1.75	1.73	1.71	1.73	1.74	1.66	1.80	1.73	1.72	0.055
D	1.63	1.62	1.73	1.63	1.66	1.68	1.75	1.73	1.72	1.68	0.057
E	1.57	1.68	1.67	1.62	1.66	1.67	1.70	1.75	1.71	1.67	0.055
F	1.63	1.68	1.74	1.65	1.69	1.72	1.79	1.78	1.76	1.71	0.063
Using cheese base II:											
A_1	1.37	1.41	1.40	1.34	1.38	1.42	1.42	1.50	1.45	1.41	0.051
B_1	1.53	1.60	1.58	1.54	1.57	1.63	1.64	1.67	1.64	1.60	0.049
C_1	1.60	1.63	1.60	1.53	1.59	1.62	1.69	1.66	1.66	1.62	0.053
D_1	1.54	1.63	1.58	1.58	1.62	1.62	1.67	1.68	1.66	1.62	0.050
E_1	1.62	1.72	1.72	1.67	1.70	1.76	1.83	1.65	1.75	1.71	0.071
F_1	1.58	1.70	1.70	1.63	1.67	1.72	1.78	1.74	1.75	1.69	0.068
Experimental control	1.31	1.38	1.37	1.32	1.36	1.39	1.42	1.40	1.41	1.37	0.043
Means	1.54	1.62	1.62	1.57	1.60	1.63	1.67	1.67	1.66	1.62	--

content in the processed cheese was slightly decreased with increasing the amount of cheese base replacement. This is in accordance with the results of Gouda (1980) who found that the salt in processed cheese was related to the age and the proportion of Ras cheese in the blends.

The mean values of salt content increased gradually during storage period showing 1.539, 1.603 and 1.658 % as fresh, 3 and 6 months of storage respectively. On the other hand, the means of salt content during storage at different temperatures showed no differences. The obtained results agree with the analysis of variance (F-test) where there was a highly significant differences between treatments, storage time and storage time x storage temperature while the treatment x storage time was insignificant(Tabl 29)

The slight increase of salt content during the storage period is due to the corresponding increase in total solids of the processed cheese. Similar observations were reported for processed Ras cheese by Gouda (1980).

Moreover, the salt content in all cheeses with different ages lies within the Egyptian legal standards which specify 4 % as a maximum content of salt in processed cheese.

5) Ash content:

Table (30) shows the ash content of processed cheese made from different blends along the storage period at different temperatures. It appears from this table that fresh processed cheese of all blends ranged from 4.94 to 5.42 % with an average of 5.20 %.

Table (28) Interaction of salt means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	1.539	-	-	-	1.539	0.1161
3 months	--	1.617	1.621	1.572	1.603	0.1239
6 months	--	1.623	1.674	1.668	1.658	0.1262
Means	1.539	1.625	1.647	1.620	1.618	--
S.D	0.1161	0.1203	0.135	0.129	--	--

Table (29) Analysis of variance (F-test) salt values of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	1.3378	0.1029	80.21	**
Storage time	2	0.1648	0.0824	64.22	**
Storage time x storage temp.	4	0.0340	0.0084	6.63	**
Treatment x storage time	26	0.0194	0.0007	0.58	n.f
Residual	52	0.0667	0.0013		
Total	97	1.6228			

Table (30) Ash content of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Fresh	Storage period: 3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
	%										
Control	5.25	5.13	4.95	5.15	5.08	5.20	5.20	5.34	5.24	5.17	0.119
Using cheese base I:											
A	4.94	4.97	4.65	4.90	4.84	5.00	5.04	5.03	5.02	4.93	0.133
B	5.20	5.19	5.02	5.16	5.12	5.14	5.35	5.12	5.20	5.17	0.099
C	5.42	5.38	5.11	5.37	5.29	5.44	5.56	5.35	5.45	5.38	0.136
D	5.23	5.32	5.15	5.30	5.26	5.41	5.40	5.25	5.35	5.30	0.094
E	5.23	5.15	4.94	5.13	5.07	5.24	5.28	5.19	5.24	5.17	0.112
F	5.33	5.18	4.99	5.17	5.12	5.16	5.17	5.31	5.21	5.19	0.113
Using cheese base II:											
A_1	4.99	4.82	4.63	4.81	4.75	4.87	4.77	5.06	4.90	4.85	0.143
B_1	5.30	5.09	5.02	5.09	5.07	5.23	5.12	5.07	5.14	5.13	0.097
C_1	5.02	4.92	5.05	4.99	4.99	5.00	5.08	5.14	5.08	5.03	0.071
D_1	5.19	5.03	5.09	5.04	5.05	5.10	5.16	5.18	5.15	5.11	0.067
E_1	5.38	5.06	5.25	5.22	5.18	5.27	5.39	5.39	5.35	5.28	0.119
F_1	5.20	5.00	5.22	5.03	5.08	5.16	5.28	5.24	5.23	5.16	0.107
Experimental control	5.18	5.20	5.02	5.31	5.18	5.31	5.23	5.34	5.29	5.23	0.111
Means	5.20	5.10	5.01	5.12	5.08	5.18	5.22	5.22	5.20	5.15	--

Table (31) clears the interactions of ash mean values of cheeses manufactured from different blends which changed during the storage period while, storage at different temperatures showed slight changes.

The evaluation of (F-test) is shown in table (32). The treatments , storage and storage time x storage temperature cleared highly significant but treatment x storage time was insignificant.

The obtained results are confirmed with the results obtained by Sood and Kosikowski (1979).

6) Total nitrogen (T.N):

The determined total nitrogen of processed cheese made from different blends are represented in table (33). The tabulated data showed a range of 2.82 to 3.01% with an average of 2.93 % in the fresh product.

The statistical analysis dealing with interaction between the storage conditions (Table 34) indicated a very slight increase in the mean values during storage period and at different storage temperatures.

The F-test (Table 35) showed that there was a highly significant between treatments, storage time and storage time x storage temperature while insignificant was existing between treatment x storage time.

The obtained results are in accordance with the results of Sood and Kosikowski (1979).

Table (31) Interaction of ash content means between storage temperatures and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Mean	S.D
Fresh	5.204	-	-	-	5.204	0.1398
3 months	-	5.103	5.007	5.120	5.077	0.1674
6 months	-	5.180	5.216	5.215	5.204	0.1558
Means	5.204	5.141	5.111	5.168	5.149	--
S.D	0.1398	0.1576	0.2109	0.1448	--	--

Table (32) Analysis of variance (F-test) for ash content for processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	1.7583	0.1353	16.75	*
Storage time	2	0.3877	0.1938	24.01	**
Storage time x storage temp.	4	0.1169	0.0292	3.62	**
Treatment x storage time	26	0.1036	0.0040	0.49	n.f
Residual	52	0.4198	0.0081		
Total	97	2.7862			

Table (33) Total nitrogen of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Fresh	Storage period: 3 months 10°C	3 months 20°C	3 months 30°C	3 months Means	6 months 10°C	6 months 20°C	6 months 30°C	6 months Means	Means	S.D
	%										
Control	2.82	2.91	2.91	2.89	2.90	2.90	2.95	2.98	2.94	2.91	0.050
Using cheese base I:											
A	2.90	2.91	2.96	3.01	2.96	2.98	2.99	3.01	2.99	2.97	0.045
B	2.95	2.99	3.01	3.04	3.01	3.01	3.06	3.08	3.05	3.02	0.043
C	2.99	2.98	2.98	3.03	3.00	3.01	3.05	3.08	3.05	3.02	0.037
D	3.01	2.97	2.97	3.03	2.99	2.97	2.99	3.06	3.01	3.00	0.036
E	2.87	2.87	2.92	2.95	2.91	2.90	2.92	2.94	2.92	2.91	0.032
F	2.97	2.97	2.99	2.97	2.98	2.97	2.98	3.01	2.99	2.98	0.015
Using cheese base II:											
A_1	2.90	2.99	3.00	3.01	3.00	3.00	3.01	3.02	3.01	2.99	0.041
B_1	2.98	3.02	3.01	3.03	3.02	3.09	3.02	3.00	3.04	3.02	0.036
C_1	2.84	2.90	2.89	2.87	2.89	2.89	2.88	2.89	2.89	2.88	0.020
D_1	2.95	2.91	2.94	2.95	2.93	2.96	2.93	2.99	2.96	2.95	0.024
E_1	3.01	2.96	2.96	2.97	2.97	2.98	3.01	3.00	3.00	2.98	0.021
F_1	2.88	2.86	2.91	2.87	2.88	2.86	2.90	2.91	2.89	2.88	0.022
Experimental control	2.98	2.96	3.02	3.03	3.00	3.00	3.07	3.10	3.05	3.02	0.048
Means	2.93	2.94	2.96	2.97	2.96	2.97	2.98	3.00	2.98	2.97	—

Table (34) Interaction of total nitrogen (T.N) content means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	2.932	-	-	-	2.032	0.0625
3 months	-	2.942	2.962	2.974	2.960	0.0514
6 months	-	2.965	2.983	3.004	2.984	0.0615
Means	2.932	2.954	2.972	2.989	2.967	--
S.D	0.0625	0.0524	0.0514	0.0622	--	--

Table (35) Analysis of variance (F-test) for total nitrogen (T.N) content of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	0.2413	0.0186	31.99	**
Storage time	2	0.0317	0.0158	27.28	**
Storage time x storage temp.	4	0.0179	0.0045	7.71	**
Treatment x storage time	26	0.0248	0.0010	1.65	n.f
Residual	52	0.0302	0.0006		
Total	97	0.3459			

7) Soluble nitrogen (S.N):

Table (36) indicates the soluble nitrogen of processed cheese manufactured from different blends during storage period of 6 months at different temperatures. It can be noticed that the soluble nitrogen in fresh cheese samples ranged from 0.342 to 0.576 % with an average of 0.490 %.

Table (37) clears the interactions of S.N between storage temperature and storage time. The obtained values cleared that samples stored for 3 months, showed a decrease than the fresh samples but after 6 months it showed a noticeable increase comparing with the fresh processed cheese samples. This may be attributed to the bacterial contamination in processed cheese which did not multiply but their metabolism can be induce change in proteins and fats which is confirmed by the results introduced by M iseeva and Michuchkova (1980). On the other hand, the mean values of soluble nitrogen as affected by the storage temperature were nearly the same at 10 and 20°C compared with the fresh processed cheese samples while it increased at 30°C to be 0.532 %.

Table (38) illustrates the analysis of varians (F-teast) for soluble nitrogen which cleared highly significant for treatments. It was observed that the S.N content in the processed cheese increased by the presence of mature Cheddar cheese or cheese base II in the blend as the experimental control, which made from 75 % cheese base I and 25 % cheese base II, contained the lowest percentage of S.N namely 0.342 %. When cheese base I used to replace young Cheddar cheese in the blends "A" to "C" the S.N content decreased by increasing the percentage of replacement. The same

Table (36) Soluble nitrogen of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period: Fresh	3 months: 10°C	3 months: 20°C	3 months: 30°C	3 months: Means	6 months: 10°C	6 months: 20°C	6 months: 30°C	6 months: Means	Means	S.D
	%										
Control	0.538	0.494	0.502	0.576	0.523	0.554	0.606	0.603	0.587	0.553	0.045
Using cheese base I:											
A	0.392	0.341	0.341	0.398	0.360	0.408	0.435	0.435	0.436	0.397	0.046
B	0.436	0.364	0.382	0.457	0.400	0.432	0.456	0.488	0.460	0.461	0.044
C	0.498	0.443	0.446	0.531	0.473	0.505	0.525	0.562	0.527	0.500	0.044
D	0.441	0.414	0.415	0.459	0.427	0.456	0.469	0.511	0.480	0.431	0.034
E	0.468	0.414	0.426	0.455	0.430	0.466	0.474	0.536	0.493	0.463	0.039
F	0.539	0.474	0.469	0.550	0.497	0.534	0.547	0.598	0.560	0.530	0.045
Using cheese base II:											
A_1	0.553	0.469	0.491	0.571	0.510	0.578	0.584	0.667	0.610	0.559	0.065
B_1	0.544	0.511	0.511	0.589	0.537	0.577	0.576	0.605	0.587	0.559	0.038
C_1	0.576	0.480	0.556	0.575	0.537	0.568	0.569	0.634	0.590	0.566	0.045
D_1	0.469	0.436	0.472	0.478	0.463	0.478	0.543	0.543	0.513	0.486	0.036
E_1	0.522	0.460	0.522	0.558	0.513	0.490	0.525	0.550	0.520	0.517	0.034
F_1	0.541	0.479	0.539	0.560	0.527	0.512	0.528	0.569	0.537	0.533	0.030
Experimental control	0.342	0.269	0.278	0.392	0.313	0.419	0.397	0.422	0.413	0.360	0.065
Means	0.490	0.431	0.454	0.511	0.465	0.499	0.515	0.554	0.522	0.493	—

Table (37) Interaction of soluble nitrogen (S.N) content means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	0.4889	-	-	-	0.4889	0.0682
3 months	-	0.4307	0.4536	0.5105	0.4654	0.0777
6 months	-	0.4986	0.5150	0.5536	0.5225	0.0651
Means	0.4889	0.4652	0.4844	0.5322	00.4932	--
S.D	0.0682	0.0704	0.0761	0.0701	--	

Table (38) Analysis of variance (F-test) for S.N content of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	0.3809	0.0293	93.26	**
Storage time	2	0.0693	0.0347	110.29	**
Storage time x storage temp.	4	0.0699	0.0175	55.59	**
Treatment x storage time	26	0.0157	0.0006	1.92	*
Residual	52	0.0163	0.0003		
Total	97	0.5521			

trend was attained when replaced the mature cheese with cheese base I in the blends "D", "E" and "F" as the S.N content of the cheese decreased with increasing the amount of the cheese base I in the blends, This was due to the less S.N content in cheese base I than the young or mature Cheddar cheese. When cheese base II was used in forming the blends, the S.N was increased proportionally to the amount of added cheese base II which contained S.N more than that of young Cheddar cheese but less than that of mature Cheddar cheese. This is clear from the results (Table 36) in treatments "A_1" to "F_1". This is attributed to that cheese base II contained high level of S.N as a result of the added proteolytic enzymes. Also a highly significant variation occurred for the storage time and storage x storage temperature. The treatment x storage time recorded only significant results.

The obtained results were higher than that found by Mahfouz et al. (1986) during survey study of imported processed chees available in the local market, this may be attributed to the different ingredients used for the method of manufacturing.

The Soluble Nitrogen/ Total Nitrogen Ratio (S.N/T.N):

The S.N/T.N ratio in the cheese is an indicator for the protein breakdown involved during ripening (Table 39). Accordingly the observed differences between the samples are related to the differences in the used blends for processed cheese manufacture which consisted of a combination of one or more natural young and mature Cheddar cheese, cheese base I and/or II which differ in their S.N content. The S.N/T.N ratio in the fresh cheeses ranged from 11.48 to 20.27 % with an average of 16.73 %.

Table (39) Ratio of soluble nitrogen (S.N) to total nitrogen (T.N) of processed cheese made from different blends during storage period period at different temperatures and mean values.

Blends	Fresh	Storage period: 3 months 10°C	3 months 20°C	3 months 30°C	3 months Means	6 months 10°C	6 months 20°C	6 months 30°C	6 months Means	Means	S.D
		%									
Control	19.10	17.01	17.29	19.94	18.08	19.12	20.58	20.22	19.97	19.04	1.399
Using cheese base I:											
A	13.51	11.71	11.52	13.21	12.15	13.69	14.55	15.50	14.58	13.38	1.428
B	14.76	12.18	12.71	15.04	13.31	14.33	14.91	15.84	15.03	14.25	1.324
C	16.65	14.89	14.94	17.55	15.79	16.78	17.20	18.28	17.42	16.61	1.277
D	14.64	13.92	13.95	15.16	14.34	15.38	15.70	16.69	15.92	15.06	0.989
E	16.32	14.42	14.58	15.44	14.81	16.07	16.21	18.23	16.83	15.89	1.282
F	18.13	15.96	15.70	18.52	16.73	17.97	18.35	19.88	18.73	17.79	1.477
Using cheese base II:											
A_1	19.10	15.67	16.38	18.99	17.01	19.29	19.40	22.12	20.27	18.70	2.134
B_1	18.29	16.95	16.99	19.43	17.79	18.67	19.05	20.17	19.30	18.51	1.203
C_1	20.27	16.55	19.23	20,00	18.59	19.65	19.75	21.92	20.44	19.62	1.606
D_1	15.90	14.99	16.05	16.22	15.75	16.16	17.86	18.18	17.40	16.48	1.134
E_1	17.36	15.53	17.63	18.81	17.32	16.45	17.47	18.30	17.40	17.36	1.099
F_1	18.79	16.75	18.52	19.51	18.26	17.92	18.21	19.58	18.57	18.47	0.997
Experimental control	11.48	9.09	9.21	12.93	10.41	13.97	12.97	13.63	13.51	11.89	2.031
Means	16.73	14.69	15.34	17.20	15.74	16.82	17.30	18.47	17.52	16.65	—

The results of interactions of S.N/T.N means between storage temperature and storage time of processed cheese from different blends are illustrated in table (40). The tabulated values indicate that they took the same trend in S.N content discussed in this relationship, which deal with storage period under different temperatures.

The (F-test) analysis showed values which was highly significant with treatments, storage time and storage time x storage temperature. Also the treatment x storage time showed a significant value.(Table 41).

The obtained results in this respect agree with some results while differ greatly with other samples of Mahfouz et al. (1986). This may be related to the chemical composition of blend ingredients used in processed cheese manufacture.

8) Lactose conent:

Table (42) shows that values of lactose content in processed cheese manufactured from different blends ranged from 2.21 to 3.07 % with an average of 2.70 % in fresh cheese samples.

The interaction resluts of lactose content between storage temperature and storage time are represented in table (43). These values indicate that content decreased during storage period development being 2.7, 2.51 and 2.27 % when fresh and after storage respectively. The values of interactions during storage at different temperatures decreased showing maximum decrease at 30°C. This can be attributed to a slight fermentation of lactose as a function of some bacteria present in processed cheese preferably grown at 30°C.

Table (40) Interaction of S.N/T.N ratio means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	16.234	–	–	-	16.734	2.478
3 months	–	14.686	15.335	17.196	15.239	2.692
6 months	–	16.818	17.298	18.466	17.522	2.275
Means	16.734	15.752	16.317	17.831	16.647	--
S.D	2.478	2.382	2.652	2.499	—	--

Table (41) Analysis of variance (F-test) for S.N/T.N ratio of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	486.414	37.417	105.46	**
Storage time	2	67.282	33.641	94.82	**
Storage time x storage temp.	4	67.637	16.909	47.66	**
Treatment x storage time	26	16.673	0.641	1.81	*
Residual	52	18.449	0.355		
Total	97	656.455			

Table (42) Lactose content of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period										
	Fresh	3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
	%										
Control	2.64	2.46	2.47	2.02	2.32	2.46	2.41	1.66	2.18	2.30	0.340
Using cheese base I:											
A	2.98	2.39	2.46	1.84	2.23	2.30	2.40	2.08	2.26	2.35	0.352
B	2.70	2.64	2.67	2.59	2.51	2.70	2.21	2.60	2.50	2.53	0.219
C	2.48	3.02	2.80	2.33	2.71	2.15	2.36	2.36	2.29	2.50	0.302
D	2.52	3.21	3.46	2.83	3.17	2.60	2.09	2.51	2.40	2.75	0.463
E	2.69	2.36	2.55	1.94	2.28	1.85	2.69	2.20	2.25	2.33	0.342
F	3.05	3.09	2.94	2.47	2.83	2.70	3.10	2.54	2.78	2.84	0.268
Using cheese base II:											
A_1	2.36	1.42	1.64	2.13	1.73	1.43	1.45	2.36	1.74	1.93	0.626
B_1	3.07	2.46	2.69	2.60	2.58	2.60	2.15	2.70	2.48	2.61	0.277
C_1	2.66	2.47	2.42	2.49	2.46	1.86	1.82	2.27	1.98	2.28	0.326
D_1	3.02	2.33	2.11	2.42	2.29	2.14	2.50	2.25	2.30	2.40	0.309
E_1	2.42	3.10	2.86	2.95	2.97	2.33	2.14	2.79	2.75	2.80	0.315
F_1	2.21	2.97	1.97	2.34	2.43	1.36	1.82	2.42	1.87	2.16	0.509
Experimental control	2.34	3.19	2.70	1.78	2.56	2.08	2.23	1.84	2.05	2.31	0.500
Means	2.70	2.65	2.55	2.31	2.51	2.18	2.31	2.33	2.27	2.43	--

Table (43) Interaction of lactose content means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	2.703	—	—	—	2.703	0.2928
3 months	—	2.650	2.551	2.312	2.505	0.4451
6 months	—	2.181	2.311	2.326	2.273	0.4059
Means	2.703	2.417	2.432	2.319	2.430	—
S.D	0.2928	0.5133	0.4635	0.3267	--	--

Table (44) Analysis of variance (F-test) for lactose content of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	5.956	0.458	4.39	**
Storage time	2	2.315	1.157	11.09	**
Storage time x storage temp.	4	1.021	0.255	2.45	n.f
Treatment x storage time	26	3.614	0.139	1.33	n.f
Residual	52	5.428	0.104		
Total	97	18.334			

The analysis of variance for lactose content of processed cheese from different blends was highly significant between treatment and storage time while storage time x storage temperature and treatment x storage time recorded insignificant results(Table 44).

The obtained results are in agreement with few imported processed cheese samples but the majorty of imported processed cheese samples (Mahfouz et al. 1986) showed higher lactose percentage than the processed cheese in the present study. This variance can be related to the difference in chemical composition of ingredients used for preparing blends for processed cheese manufacture.

This low lactose content can be considered as a desirable property from the preservation of processed cheese as point of view since investigators refered that the highly the lactose content in the processed cheese, the faster the spoilage of it. This point was taken in consideration during the preparation of cheese base I and II through the using of diafiltration.

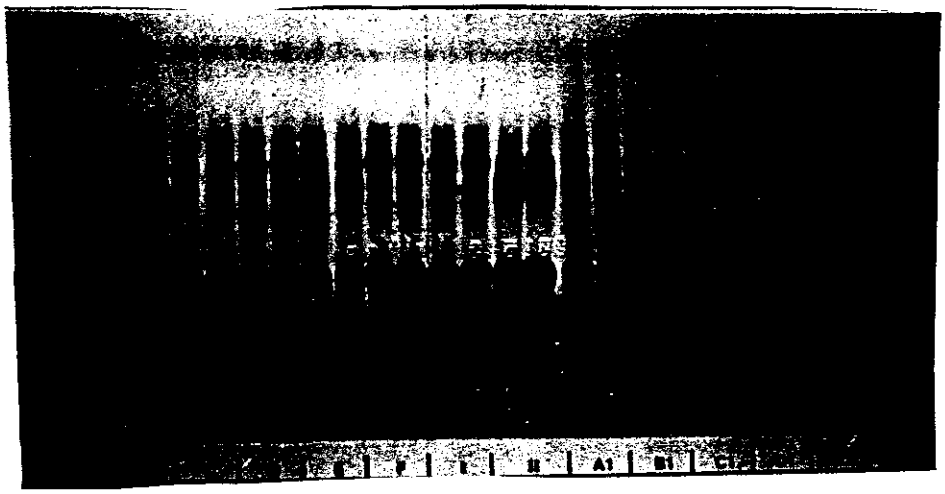
9) Electrophoretic pattern of block processed cheese:

Fig (15) illustrates the pattern of fresh processed cheese proteins made from different blends. The examined cheeses differ in the number and intensity of the different protein blends. This can be attributed to the use of Cheddar cheeses of different ripening period (young and mature) and two different cheese-base (differ in protein degradation) as ingredients in the manufacture of block processed cheese.

The α_s-and β- casein band can be detected in all resultant processed cheeses compared with the band of standard sodium caseinate.

Fast moving fraction
α- casein
β-lactoglobulin
β- casein

Slow moving fraction



Type	Code	Type	Code
Sodium caseinate	S	Processed cheese (Experi-	
Processed cheese (A)	A	mental control)	II
Processed cheese (B)	B	Processed cheese (A_1)	A_1
Processed cheese (C)	C	Processed cheese (B_1)	B_1
Processed cheese (D)	D	Processed cheese (C_1)	C_1
Processed cheese (E)	E	Processed cheese (D_1)	D_1
Processed cheese (F)	F	Processed cheese (E_1)	E_1
Processed cheese (control)	I	Processed cheese (F_1)	F_1

Fig (15) Electrophoretic pattern of processed cheese made from different blends (Fresh samples).

The electrophoretic pattern of cheese proteins was characterized by the presence of several bands of mobilities lower than that of β-casein. There was also several small bands of mobilities in between β- and α_{s}-casein and with mobilities higher than β-casein. These bands were reported to arise from degradation of α_{s_1}-casein. Except of the control the electrophoretic patteren of the processed cheeses showed the presence of a small bands of β-lactoglobulin. The presence of this band is mainly due to enclosure of whey proteins present in the retentate which used in the manufacture of cheese-base I and II. This band was reported by many workers (Dekoning, 1980; El-shabrawy, 1985 and Abdou et al, 1988).

Fig 16 and 17 cleared that the pattern of cheese proteins was nearly the same in all treatments and all over the storage period at different temperatures. This indicating to modifications in the cheese proteins during processed or storage. These results are in accordance with those reported by Gouda and El-Shibiny (1987).

(a)

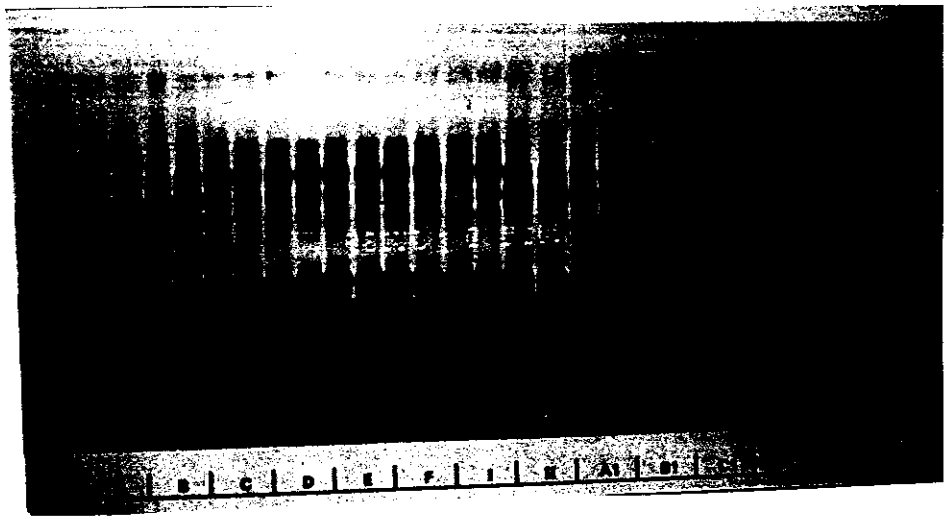
Fast moving fraction

∝- casein

β-lactoglobulin

β- casein

Slow moving fraction



(b)

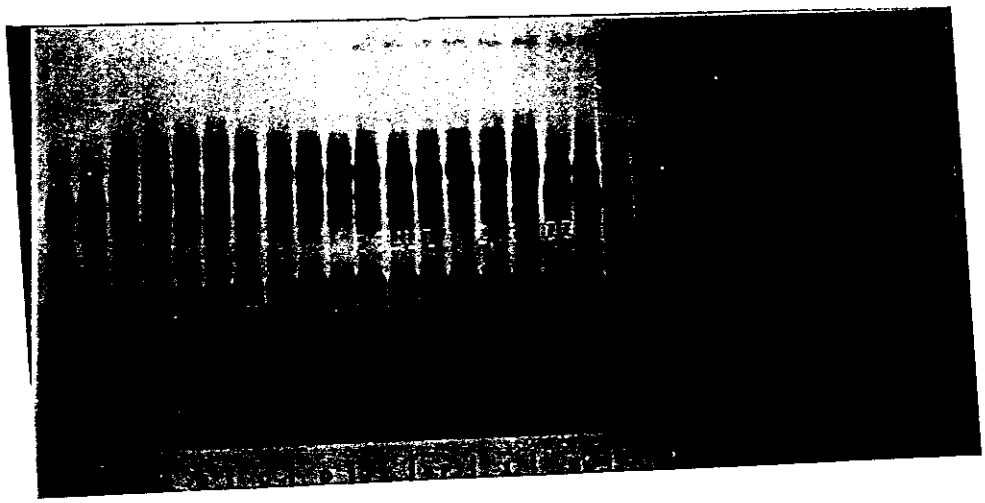
Fast moving fraction

∝- casein

β-lactoglobuline

β- casein

Slow moving fraction



(c)

Fast moving fraction

∝- casein

β-lactoglobulin

β- casein

Slow moving fraction

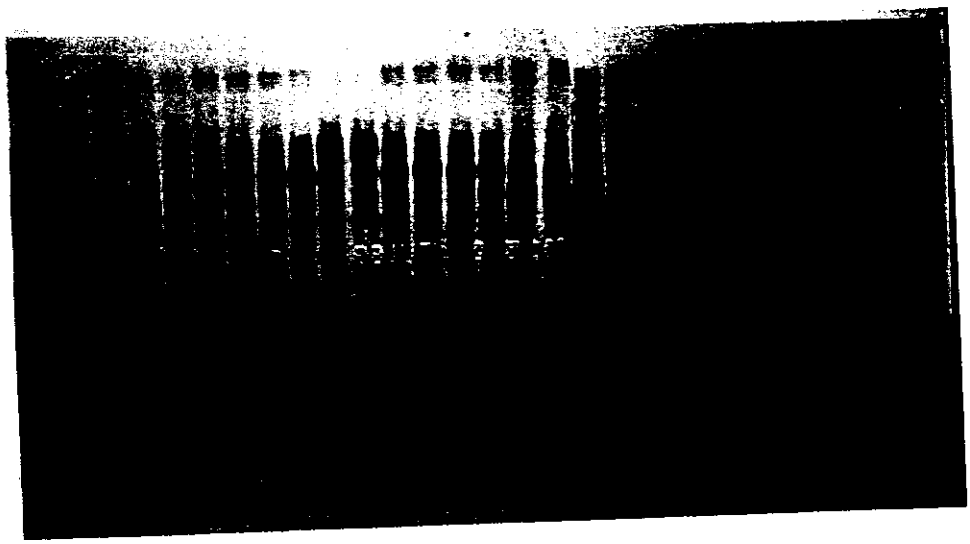


Fig (16) Electrophoretic pattern of processed cheese made from different blends after 3 months storage at different temperatures: a) 10°C, b) 20°C, and c) 30°C.

(a)

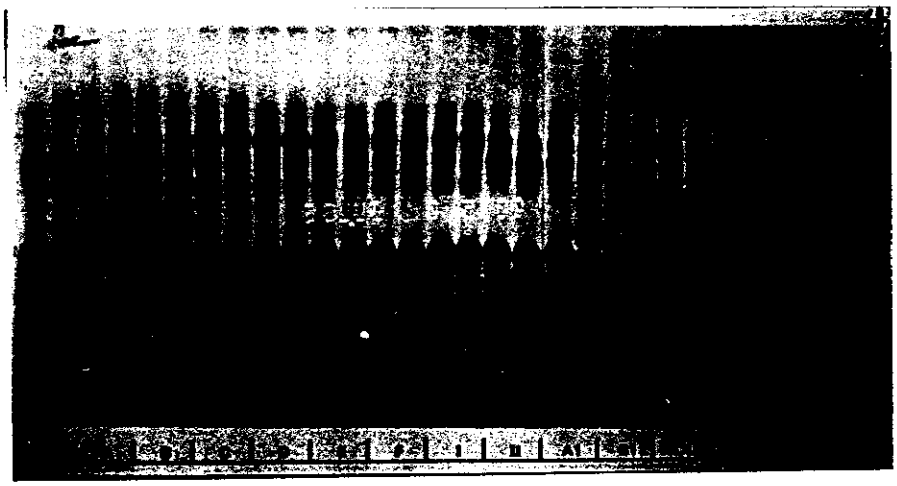
Fast moving fraction

α- casein

β-lactoglobulin

β- casein

Slow moving fraction



(b)

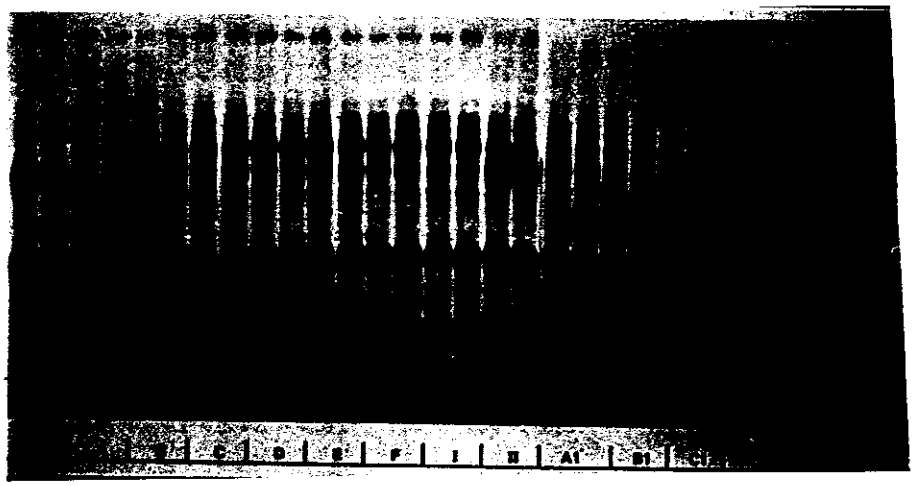
Fast moving fractin

α- casein

β-lactoglobulin

β- casein

Slow moving



(c)

Fast moving fraction

α- casein

β-lactoglobulin

β- casein

Slow moving fraction

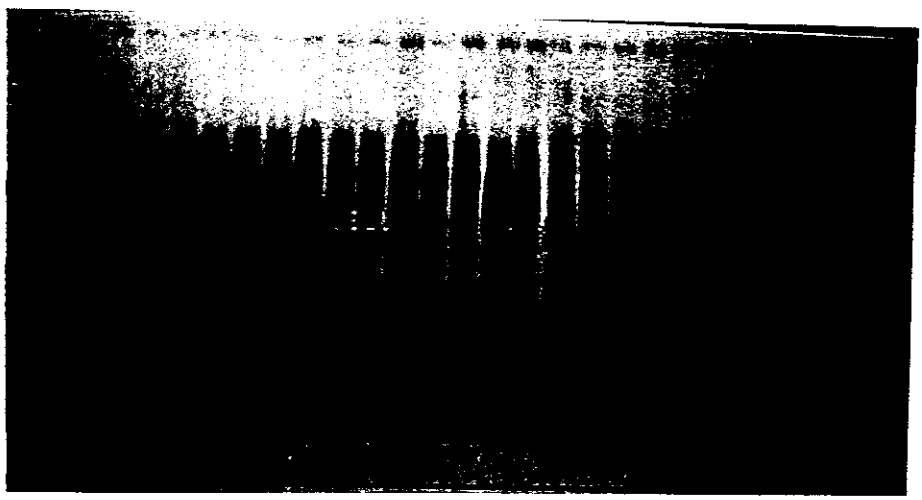


Fig (17) Electrophoretic pattern of processed cheese made from different blends after 6 months storage at different temperatures. a) 10°C, b) 20°C and c) 30°C.

II. Microbiological Properties of Processed Cheese:

1) Total bacterial count:

Data presented in table (45) shows the total bacterial count of processed cheese from different blends during storage period of 6 months at 10°, 20° and 30°C. The number of bacterial count of fresh processed cheese ranged from 250 to 1550 C.F.U/g cheese with an average of 671 C.F.U/g cheese.

Regarding the interactions of storage period (Table 46), it was found that the total bacterial count decreased during the first period of storage as it was 671 C.F.U/g when fresh and reached 408 C.F.U/g cheese after 3 months while it reached 518 C.F.U/g cheese in average but did not reach the initial counts.

In respect of the interactions of total bacterial count during storage at different temperatures, it was decreased at 10°C than the initial count, however, the counts increased to reached the maximum at 30°C. The average bacterial counts recorded 319, 302 and 603 C.F.U/g at 10°, 20°and 30°C after 3 months respectively; while it recorded 532, 584 and 617 C.F.U/g after 6 months in the same order.

The analysis of variance (F-test) for total bacterial count of processed cheese made from different blends was insignificant between treatments and treatment x storage time, however, it was highly significant with storage time and significant for storage time x storage temperature(Table 47).

The obtained results showed the same trend during the storage period as stated by Yankov (1975). In respect of the total

Table (45) Total bacterial count of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period										
	Fresh	3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
	C.F.U.										
Control	350	300	245	150	232	150	500	450	367	306	137.1
Using cheese base I:											
A	250	300	100	85	162	800	400	900	700	405	324.0
B	700	300	225	115	213	650	250	450	450	384	222.7
C	750	250	325	990	522	350	900	700	650	609	299.0
D	600	450	400	355	402	650	700	440	597	514	134.4
E	650	400	330	1225	652	700	900	350	650	651	329.0
F	1050	350	165	350	288	550	550	700	600	531	288.0
Using cheese base II:											
A_1	500	250	390	1610	750	151	220	850	407	567	516.0
B_1	1550	300	230	940	490	800	400	600	600	689	460.0
C_1	600	450	130	165	248	750	850	500	700	492	273.0
D_1	550	250	755	915	640	600	650	450	567	596	213.4
E_1	450	215	415	1040	557	200	550	950	567	546	332.0
F_1	700	400	125	255	260	300	500	550	450	404	195.4
Experimental control	700	250	400	245	298	800	800	750	783	564	225.5
Means	671	319	302	603	408	532	584	617	578	518	--

C.F.U. = Colony forming unit.

Table (46) Interaction of total bacterial count means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	671.0	-	-	-	671.0	317.3
3 months	-	319.0	302.0	603.0	408.0	330.9
6 months	-	532.0	584.0	617.0	578.0	221.9
Means	671.0	425.4	443.0	610.0	518.0	-
S.D	317.3	211.8	243.2	370.9	-	-

Table (47) Analysis of variance (F-test) for total bacterial count of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	1088710	83747	1.19	n.f
Storage time	2	986158	493079	7.02	**
Storage time x storage temp.	4	849784	212446	3.03	*
Treatment x storage time	26	2217904	85304	1.21	n.f
Residual	52	3651282	70217		
Total	97	8793838			

counts, it agrees with few samples of imported processed cheese tested by Malfouz et al. (1986), while, the majority of these tested samples were higher in counts than those in our present study. Similar results were reported by Mahmoud et al. (1975) and Gouda (1980). It can suggested that the low counts of processed cheese in the present study is due to inhibition of nisin for bacterial growth as nisin was added as a preservative at a rate of 100 RU/g. This result was in accordance with Dawood (1971), who stated that nisin can prevent the germination and proliferation of the remained spores in the processed cheese. Also Meyer (1973) confirmed these results. In addition Kumar and Brave (1978) indicated that the addition of 100 RU nisin/g processed cheese was sufficient to check any significant increase in bacterial counts during storage.

2) Yeasts and moulds:

Table (48) indicates that yeasts and moulds were absent in some samples of processed cheese manufactured from different blends however, they showed a maximum of 60 C.F.U/g cheese in fresh samples with an average of 14.6 C.F.U/g. These counts can be attributed to the contamination during packaging.

The interactions of yeasts and moulds with storage temperatures and the storage time of processed cheese from different blends cleared that the count of yeasts and moulds increased during the storage period. The interaction of these microorganisms at different temperatures cleared that the counts increased at 10°C while, decreased at 20 and 30°C(Table 49).

The F-test for yeasts and moulds of processed cheese from different blends indicates insignificant relations between all sources of analysis(Table 50).

Table (48) Yeasts and moulds of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period										
	Fresh	3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
	C.F.U										
Control	0	0	5	0	1.7	0	5	0	1.7	1.4	2.44
Using cheese base I:											
A	5	0	5	50	18.3	30	10	5	15.0	15.0	18.26
B	10	50	0	20	23.3	55	5	0	20.0	20.0	23.27
C	10	0	45	0	15.0	40	30	0	23.3	17.9	19.97
D	0	0	5	10	5.0	0	0	0	0.0	2.1	3.93
E	35	0	10	0	3.3	0	10	0	3.3	7.9	12.86
F	20	0	0	10	3.3	10	60	0	23.3	14.3	21.49
Using cheese base II:											
A_1	50	65	5	10	26.7	55	0	45	33.3	32.9	26.90
B_1	60	0	36	60	32.0	5	0	50	18.3	30.1	27.90
C_1	0	0	0	0	0.0	75	50	25	50.0	21.4	30.40
D_1	0	0	6	50	18.7	60	5	0	21.7	17.3	26.04
E_1	5	90	0	5	31.7	0	35	10	15.0	20.7	32.80
F_1	5	0	5	20	8.3	0	0	0	0.0	4.3	7.32
Experimental control	5	75	29	5	36.3	20	60	0	26.7	27.7	29.30
Means	14.6	20.0	10.8	17.1	16.0	25	19.3	9.6	18.0	16.6	--

C.F.U = Colony forming unit.

Table (49) Interaction of yeasts and moulds means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	14.60	–	–	–	14.60	19.66
3 months	-	20.00	10.80	17.10	16.00	24.15
6 months	-	25.00	19.30	9.60	18.00	23.22
Means	14.6	22.50	15.04	13.39	16.00	--
S.D	19.66	30.17	19.43	19.25	--	--

Table (50) Analysis of variance (F-test) for yeasts and moulds of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	9101.6	700.1	1.22	n.f
Storage time	2	149.3	74.7	0.13	n.f
Storage time x storage temp.	4	2309.8	577.5	1.01	n.f
Treatment x storage time	26	9765.5	375.6	0.65	n.f
Residual	52	29852.2	574.1		
Total	97	51178.5			

3) Aerobic sporeformers:

Table (51) shows that the aerobic sporeformer counts of processed cheese were from 14 to 150 C.F.U/g processed cheese with an average of 82.4 C.F.U/g cheese in fresh product.

The interaction of aerobic sporeformer means between storage temperature and storage time of processed cheese made from differemt blends are tabulated in table (52) this table indicates that the counts in fresh processed cheese was 82.4 C.F.U/g cheese then increased after the 3 months storage reaching 123.7 and 110.7 C.F.U/g after 6 months. Regarding the interactions of these organisms at different temperatures the initial count increased slightly at the storage temperature of 10°C while at the other two storage temperatures, the increase in counts compared with the initial was less. This cleared that the present aerobic sporeformers in the tested processed cheese multiply preferably at lower (10°C) temperature than higher (20 and 30°C) temperatures and it must mentioned in this respect that the condition in processed cheese is generally anaerobic which is unfavorable to the aerobic sporeformers.

The statistical analysis (F-test) cleared that there were highly significant relation between treatments and storage time x storage temperature while the storage time and treatment x storage time were insignificant.(Table 53).

The lower counts of aerobic sporeformers in the manufacture processed cheese than that recorded by many investigators including the results which was obtained in this investigation (survey part) may be related to the preventation or retarding effect of

Table (51) Aerobic sporeformers counts of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period: Fresh	3 months: 10°C	3 months: 20°C	3 months: 30°C	3 months: Means	6 months: 10°C	6 months: 20°C	6 months: 30°C	6 months: Means	Means	S.D
	C.F.U.										
Control	145	170	60	95	108.3	235	160	110	168.3	139.3	57.30
Using cheese base I:											
A	60	70	30	40	46.7	45	55	45	48.3	49.3	13.36
B	75	75	180	25	93.3	120	95	55	90.0	89.3	49.90
C	100	140	120	100	120.0	170	60	100	110.0	112.9	35.00
D	150	255	275	140	213.3	265	85	65	138.3	172.1	84.30
E	115	215	125	220	186.7	245	100	65	136.7	155.0	70.20
F	115	180	130	135	148.3	180	250	85	171.7	153.6	54.40
Using cheese base II:											
A_1	15	120	35	295	150.0	75	100	90	71.7	102.1	90.70
B_1	30	30	50	145	75.0	230	55	50	111.7	84.3	75.30
C_1	35	135	205	205	181.7	140	60	95	98.3	125.0	66.30
D_1	14	85	65	45	65.0	150	85	105	113.3	78.4	43.50
E_1	145	115	45	230	130.0	105	65	90	86.7	113.6	60.90
F_1	105	155	65	85	101.0	70	95	100	88.3	96.4	29.80
Experimental control	15	145	120	70	111.7	185	95	70	116.7	100.0	55.80
Means	82.4	132.9	107.5	130.7	123.7	158.2	97.0	76.8	110.7	112.2	--

C.F.U. = Colony forming unit.

Table (52) Interaction of aerobic sporeformers means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Mean	S.D
Fresh	82.4	-	-	-	82.4	49.0
3 months	-	132.9	107.5	130.7	123.7	69.7
6 months	-	158.2	97.0	76.8	110.7	61.73
Means	82.4	145.5	102.3	103.8	112.2	—
S.D	49.0	63.3	62.1	64.7	--	--

Table (53) Analysis of variance (F-test) for aerobic sporeformers of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	104566	8044	2.58	**
Storage time	2	18047	9023	2.89	n.f
Storage time x storage temp.	4	55819	13955	4.47	**
Treatment x storage time	26	64139	2467	0.79	n.f
Residual	52	162281	3121		
Total	97	404852			

nisin on the germination and profileration of aerobic sporeformers as suggested by Dawood (1971) and Meyer (1973).

Comparing the aerobic sporeformers with the total count, it appears that the formers constituted a large proportion of the later.

4) Anaerobic sporeformers:

Data presented in table (54) clears anaerobic sporeformer counts in processed cheese manufactured from different blends during storage period at different temperatures, it must mentioned that the proteolytic anaerobic sporeformers was always absent during all the course of this investigation. The saccharolytic anaerobic sporeformers was not detected in some cheese samples manufactured from different blends while the counts in the others being ranging from 4 to 20 C.F.U/g. with an average of 7.07 C.F.U/g. in fresh processed cheese samples. It was noticed that the processed cheese made fully from the cheese base I and II and that contained 75 % of the cheese base I or cheese base II (blends A and A_1) were free from the anaerobic sporeformers. However, the presence of these organisms in some processed cheeses were not able to cause taints in them during storage as indicated by the organoleptic evaluations. The low counts of anaerobic sporeformers in processed cheese can be related to the high microbiological quality of the ingredients used in blends for processed cheese manufacture. Some investigators, reported that these types of organisms were present in processed cheese in related to high counts (Griffiths, 1939; Hood and Bowen, 1950; Hood and Smith, 1951 and Galesloot, 1961). In addition, these low counts can be attributed

Table (54) Anaerobic sporeformers in processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period										
	Fresh	3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
	C.F.U										
Control	4	4	4	0	2.67	4	4	4	4.00	3.43	1.512
Using cheese base I:											
A	0	0	0	0	0.00	0	0	0	0.00	0.00	0.000
B	4	0	0	0	0.00	4	0	0	1.33	1.14	1.952
C	15	0	9	0	3.00	0	0	0	0.00	3.43	6.110
D	0	0	4	4	2.67	0	0	9	3.00	2.43	3.460
E	20	3	15	0	6.00	4	9	0	4.33	7.29	7.240
F	20	0	0	0	0.00	4	0	0	1.33	4.00	7.300
Using cheese base II:											
A_1	0	0	0	0	0.00	0	0	0	0.00	0.00	0.000
B_1	3	0	0	0	0.00	0	0	0	0.00	0.43	1.134
C_1	20	4	0	0	1.33	0	0	0	0.00	3.43	7.460
D_1	4	4	0	0	1.33	0	4	0	1.33	1.71	2.138
E_1	0	4	4	0	2.67	0	4	4	2.67	2.29	2.138
F_1	9	9	0	0	3.00	7	0	0	2.33	3.57	4.500
Experimental control	0	0	0	0	0.00	0	0	4	1.33	0.57	1.512
Means	7.1	2.0	2.6	0.3	1.62	1.6	1.8	1.5	1.64	2.41	--

C.F.U = Colony forming unit.

Table (55) Interaction of anaerobic sporeformers means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	7.07	–	–	–	7.07	8.150
3 months	–	2.00	2.57	0.29	1.62	3.172
6 months	–	1.64	1.79	1.50	1.64	2.583
Means	7.07	1.82	2.18	0.89	2.41	--
S.D	8.150	2.539	3.682	2.132	--	--

Table (56) Analysis of variance (F-test) for anaerobic sporeformers of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	362.531	27.887	3.39	**
Storage time	2	355.197	177.599	21.59	**
Storage time x storage temp.	4	40.190	10.048	1.22	n.f
Treatment x storage time	26	719.945	27.690	3.37	**
Residual	52	427.809	8.227		
Total	97	1905.623			

to the function of the added nisin (100 RU/g) which can prevent or retard the growth of this types of bacteria specially at low counts where some of the nisin carry over in the recovery medium. The obtained results are in agreement with those found by Khadr (1978).

The interaction of anaerobic sporeformers between storage temperature and storage time of processed cheese (Table 53) showed a reduction in counts during the storage period. The same trend can be observed at different temperatures during storage period.

F-test analysis for the results of anaerobic sporeformers present in processed cheese introduced a highly significant in treatments, storage time and treatment x storage time but storage time x storage temperature showed insignificant results(Table 56).

5) Coliform detection:

The presence of coliform in processed cheese means post processing contamination and can be used as indicater for pathogenic bacteria and bad handling of the dairy products. Thus, it was of great importance to detect the presence of this group in the manufacture of processed cheese. The obtained results for all cheese samples produced by different blends and stored for 6 months at different temperatures, cleared the absence of coliform group. This indicate that there was no post processing contamination since the manufacture processing was carried out under good hygenic conditions. This result was confirmed by the survey study of the imported processed cheese available in the local market of Egypt as stated by Mahfouz et al. (1986).

III. Physical Properties of Processed Cheese:

Processed cheese cannot be graded on the principles used for the grading of Cheddar cheese, since the acceptability of processed cheese depends mainly on its physical characteristics, although uniformity of colour and flavour are also essential. All cheese products are basically oil/water emulsion. Natural cheese is a nearly perfect emulsion, stabilized by natural surfactants the cheese proteins. However, these proteins are adversely affected (denatured) by processing, specially by the heat and by pH changes as small as 1/2 unit (Webb et al, 1974), the consequences can be poor texture and/or oil separation.

1) Oil separation:

Oil separation is a defect characterized by the separation of oil or water (or both) from processed cheese (Thomas, 1977). It can appear as a slight sweating on the surface of cheese or as small oil droplets through out the cheese body.

This defect appears mainly where cheese is stored at a high temperature for long period, therefore, it is quite normal after leaving the factory and it may appear during store.

In the present study this defect was not detected because a correct processing procedure was applied in the manufacture of processed cheese. Moreover, the pH range of blends was 5.41 to 5.66 which is the more suitable pH where Thomas (1977) reported that the pH of processed cheese should never be less than 5.4 to avoid the oil separation.

The amount of emulsifying agent used by a suitable combination of different commercial Joha salts SE, C and T to achieve the desirable pH. All other steps in the manufacturing of processed cheese were carried out correctly in order to avoid this defect.

2) Melting index:

The melting index is expressed in terms of percentage decrease in cylinder cheese hight after special heat treatment.

Table (57) represents the melting properties of block processed cheese manufactured from different blends during storage period of 6 months at different temperatures. The melting index of processed cheese were affected by the composition of the blends as well as the period and temperature of the storage, however, the melting index of the processed cheese manufactured from different blends were more pronounced when being fresh as it recorded 1.96 to 15.69 % with an average of 6.13 %.

Table (58) indicates the interactions of melting index means between storage temperature and storage time of processed cheese made from different blends, the tabulated values clear that melting index of fresh processed cheese increased after 3 months then it decreased with storage progress. Regarding the interaction between melting index and the storage temperature, there was no apparent trend towards the different blends but the mean values at 20°C was high. The means recorded were 6.31, 8.44, 9.04 and 8.04 % when fresh and at 10°, 20° and 30°C respectively.

The statistical analysis in table (59) evaluated by F-test cleared that the storage time was highly significant while

Table (57) The melting index of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period: Fresh	3 months: 10°C	3 months: 20°C	3 months: 30°C	3 months: Means	6 months: 10°C	6 months: 20°C	6 months: 30°C	6 months: Means	Means	S.D
	%										
Control	5.88	14.66	13.96	13.72	14.12	5.00	18.75	9.38	11.04	11.62	5.03
Using cheese base I:											
A	9.82	10.83	9.28	6.67	8.93	2.50	5.88	10.00	6.13	7.13	2.98
B	5.88	8.67	6.46	7.45	7.53	3.53	6.45	9.68	6.39	6.80	2.14
C	5.88	9.29	16.25	9.55	11.70	5.00	9.09	6.45	6.85	8.79	3.76
D	5.88	11.46	12.29	9.41	11.05	9.38	2.94	9.68	7.33	8.72	3.25
E	3.96	7.86	9.52	5.63	7.67	12.12	9.09	3.23	8.15	7.34	3.22
F	1.96	10.63	5.95	9.59	8.72	9.38	8.57	8.11	8.68	7.74	2.94
Using cheese base II:											
A_1	5.88	6.69	8.96	3.34	6.33	3.13	8.82	2.94	4.96	5.68	2.62
B_1	15.69	8.75	11.69	9.79	10.07	3.13	2.94	10.00	5.36	8.85	4.56
C_1	9.82	16.92	18.00	14.11	16.35	3.13	5.88	9.09	6.03	10.99	5.58
D_1	1.96	15.63	12.89	6.67	11.73	3.13	2.94	2.94	3.00	6.59	5.50
E_1	3.92	8.89	1.66	5.88	5.48	3.33	11.76	13.45	9.58	7.01	4.52
F_1	9.82	12.86	8.81	6.28	9.31	12.50	13.33	6.45	10.76	10.01	2.98
Experimental control	1.96	9.11	4.79	9.38	7.76	9.38	6.06	6.25	7.23	6.70	2.79
Means	6.31	10.87	10.04	8.39	9.77	6.01	8.05	7.69	7.25	8.19	—

Table (58) Interaction of melting index means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	6.31	–	–	–	6.31	3.860
3 months	–	10.87	10.04	8.39	9.77	3.665
6 months	–	6.01	8.05	7.69	7.25	3.801
Means	6.31	8.441	9.043	8.039	8.19	—
S.D	3.86	4.156	4.499	3.037	—	—

Table (59) Analysis of variance (F-test) for melting index of processed cheese made from different blends.

Source of variance	d.F	S.S	M.S	V.r	Sign.
Treatment	13	275.979	21.229	2.14	*
Storage time	2	191.097	95.549	9.61	**
Storage time x storage temp.	4	78.012	19.503	1.96	n.f
Treatment x storage time	26	466.073	17.926	1.80	*
Residual	52	516.952	9.941		
Total	97	1528.113			

treatments and treatment x storage time recorded only significant results but storage time x storage temperature was insignificant. These obtained results differ than those obtained by Gouda (1980). This can be attributed to the different ingredients used in the blends where he used mainely Ras cheese while the present study used Cheddar cheese and cheese-base I and II in the blends for manufacturing block processed cheese. In addition, these differences can be attributed to the variation of the manufacturing process, kind of emulsifier agents and other technological aspects.

The melting index values were evaluated by the correlation coefficient to study the relation between the different chemical properties of the cheese and this physical property in order to clear the most effective parameters in this respect. Table (60) showed that the melting index was highly correlated with T.N for cheese stored at 10°C but it was in a low correlation with the other chemical parameters of the processed cheese. Thomas (1977) found that pH does not seem to have effect on the melting index that confirms the obtained results regarding the pH values. Arnott et al. (1957) and Gupta et al. (1984) studied also some correlations and they stated that the correlations between meltability of process cheeses and pH, moisture or fat contents were not significant which agreed with the present results.

3) Penetrometer reading:

Firmness is one of the most important characteristics of processed cheese with respect to consumer preference and sensory preception. Table (61) shows the penetrometer reading of block processed cheese made from different blends along the storage

Table (60) The correlation coefficient (r) between some physical properties and chemical parameters of processed cheese stored at $10^{o}C$.

Test	Melting index	Penetrometer reading	Consist-ency	Hardness	Cohesi-veness
pH	- 0.129	0.659	- 0.486	- 0.607	0.528
T.S	- 0.136	- 0.252	0.198	0.218	0.113
Fat	- 0.110	- 0.282	0.115	0.238	0.089
F/DM	0.041	- 0.058	- 0.067	0.031	- 0.083
Salt	0.176	0.365	- 0.450	- 0.369	0.557
Ash	- 0.132	0.205	- 0.285	- 0.071	0.402
T.N	- 0.356	0.662	0.560	0.662	- 0.319
S.N	- 0.126	0.308	- 0.444	- 0.023	0.089
S.N/T.N	- 0.070	0.400	- 0.515	- 0.124	0.131
Lactose	0.109	0.187	- 0.050	- 0.298	0.215

Table (61) The penetrometer readings of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Fresh	Storage period/months: 3 — 10°C	20°C	30°C	Means	6 — 10°C	20°C	30°C	Means	Means	S.D
		(0.1 mm)									
Control	66.0	60.0	52.5	29.5	47.33	49.5	25.5	20.5	31.83	43.36	18.00
Using cheese base I:											
A	36.0	41.5	30.5	26.0	32.67	25.5	32.0	11.5	23.00	29.00	9.50
B	45.5	34.5	27.0	21.0	27.83	28.5	14.0	10.0	17.50	25.93	12.27
C	51.0	41.0	45.0	23.5	36.50	45.0	26.5	11.5	27.67	24.79	14.42
D	47.0	47.5	42.5	22.0	37.33	37.5	30.5	12.5	26.83	34.21	13.25
E	48.0	54.0	34.5	29.5	39.33	44.0	23.0	12.5	26.50	35.07	14.67
F	57.5	44.0	39.5	26.5	36.67	34.0	29.5	12.0	25.17	34.71	14.32
Using cheese base II:											
A_1	46.5	26.5	16.5	11.5	18.17	17.5	5.5	6.5	9.83	18.64	14.23
B_1	44.0	24.5	26.0	17.5	22.50	28.0	8.0	6.0	14.00	21.93	13.03
C_1	73.0	52.5	42.0	26.0	40.17	45.0	21.5	10.5	25.67	38.64	21.09
D_1	48.5	36.5	32.5	15.0	28.00	25.5	11.5	11.5	25.17	29.71	13.23
E_1	54.0	44.0	41.5	23.0	36.17	32.5	24.0	13.0	24.86	33.86	14.32
F_1	72.0	64.5	57.0	36.0	52.50	53.5	38.5	19.5	37.17	48.71	18.27
Experimental control	41.0	27.5	21.5	18.0	22.33	33.0	9.5	15.0	19.17	23.64	10.92
Means	52.14	42.82	36.32	23.18	34.11	36.93	22.39	12.32	23.88	32.30	—

period at different temperatures. It is obvious from these results that the means of penetrometer reading for all processed cheese considerably varied with the composition as well as along the storage period at different temperatures. However, the differences in firmness measured by the penetrometer test of the resultant processed cheese are more obvious when fresh as they ranged from 36 to 73 with an average of 52.14 (0.1 mm). Processed cheese made from a blend containing mainly Cheddar cheese of 5 and 10 months old had soft body as the penetrometer reading was 66 (0.1 mm). Replacement of Cheddar cheese in the blend with cheese-base increased the firmness of the resultant cheese as the experimental control which made from cheese base had a very low penetrometer reading being 41 (0.1 mm). Generally, incorporating cheese-base I or II in the blends tend to induce a firmer body of the resultant processed cheese having a low penetrometer reading. Moreover, it was noticed that the increase in the firmness of the processed cheese become pronounced as the proportion of the cheese base I (without ripening) was incresed in the blend where it was 36 (0.1 mm) in treatment "A". On the other hand, when cheese-base II was used with high proportion (treatment "A_1") it gave 46.5 (0.1 mm). Similar observation were reported by Templeton and Sommer (1934), Palmer and Sly (1943) and Gouda (1980).

Table (62) illustrates the interactions of penetrometer reading values between storage temperatures and storage period of block processed cheese made from different blends. From this table one can notice that the penetrometer reading values were decreased as the storage period prolonged showing 52.14, 34.11

Table (62) Interaction of penetrometer reading means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	52.14	–	-	-	52.14	11.53
3 months	-	42.82	36.32	23.18	34.11	13.09
6 months	-	36.93	22.39	12.32	23.88	13.10
Means	52.14	39.87	29.36	17.75	32.30	-
S.D	11.23	11.36	12.66	7.65	-	-

Table (63) Analysis of variance (F-test) for penetrometer reading of processed cheese made from different blends.

Source of variance	d.F	S.S	M.S	V.r	Sign.
Treatment	13	6194.30	476.48	17.35	**
Storage time	2	8626.48	4313.24	157.08	**
Storage time x storage temp.	4	7088.94	1772.24	64.54	**
Treatment x storage time	26	982.76	37.80	1.38	n.f
Residual	52	1427.89	27.46		
Total	97	24320.39			

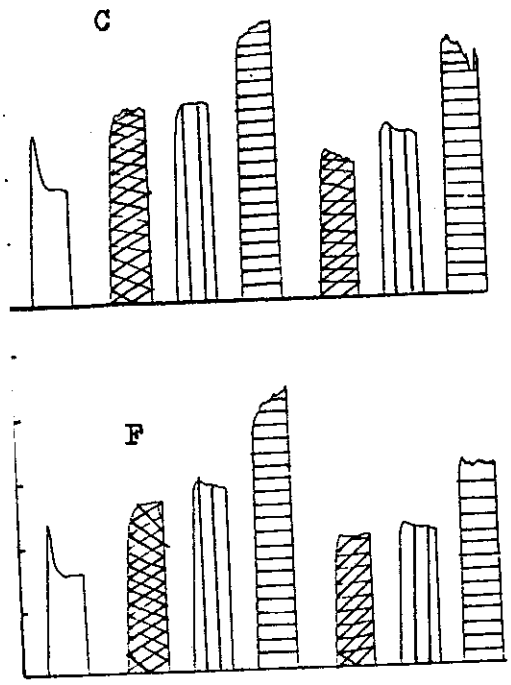
and 23.88 (0.1 mm) when fresh, 3 and 6 months storage respectively. Moreover, the reading values decreased gradually with great differences at the used temperatures during storage as the penetrometer gave mean readings of 52.14, 39.87, 29.36 and 17.75 (0.1 mm) when fresh and after storing at 10°, 20° and 30°C successively.

Table (63) illustrates the analysis of variance (F-test) for penetrometer reading of the resultant processed cheese manufactured from different blends. It is obvious that treatments, storage time and storage time x storage temperature were highly significant but treatment x stroage period was insignificant.

The correlation coefficient between penetrometer readings and chemical parameters are represented in table (60). The pH values and T.N were highly correlated with the penetrometer reading for processed cheese samples stored at 10°C (r = 0.659 and 0.662 respectively). The S.N/T.N, salt and S.N came in the second order in the correlation with penetrometer readings (r= 0.400, 0.365 and 0.308 consequently).

4) Consistency:

Table (64) and Fig (18) illustrate the consistency values of processed cheese made from different blends along with the storage period of 6 months at different temperatures. The tabulated values in fresh processed cheese from different blends ranged from 50.5 to 137 g with an average of 97.3 g. It's clear that a great difference in the resultant processed cheese are present. The processed cheese mainly manufactured from cheese-base I and II showed the maximum consistency value (137 g) but the processed cheese fully made



Fig

from Cheddar cheese (control) showed very low value (54.5 g).

The interaction of consistency mean values between storage temperature and storage time of processed cheese made from diffe-rant blends and stored for 6 months at different temperatures are illustrated in table (65). It can be observed that the consistency mean values increased as it was fresh from 97.5 to 201.3 g after 3 months followed by a decrease in the obtained values to be 154 g after 6 months storage period. On the other hand, the consistency mean values increased gradually at differ-ent temperatures reaching the maximum at 30°C.

The statistical analysis (F-test) for consistency of pro-cessed cheese made from different blends are present in table (66). All the sources of variance involved in cheese process-ing gave highly significant values.

Table (60) recorded correlation coefficient values bet-ween consistency of processed cheese and the chemical parameters when stored at 10°C.It is obvious that T.N,S.N,S.N/T.N and pH values correlated highly with the consistency of the resultant pro-cessed cheese. The other chemical parameters which could be of minor effect on the consistency and gave low values of correlat-ion were fat, lactose and T.S.

5) Texture evaluation:

Texture plays an important role in the quality of cheese, but the textural measurments of cheese are complicated and con-fused

Table (65) Interaction of consistency means between storage temperature and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	97.50	-	-	-	97.50	27.99
3 months	-	152.20	187.00	264.80	201.30	93.30
6 months	-	119.10	143.60	199.40	154.00	62.20
Means	97.50	135.63	165.30	232.10	166.20	-
S.D	27.99	49.46	77.60	86.50	-	-

Table (66) Analysis of variance (F-test) for consistency of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	300904.3	23146.3	31.58	**
Storage time	2	12419.1	62095.5	84.73	**
Storage time x storage temp.	4	140541.6	35135.4	47.94	**
Treatment x storage time	26	46093.8	1772.8	2.42	**
Residual	52	38107.4	732.8		
Total	97	649838.0			

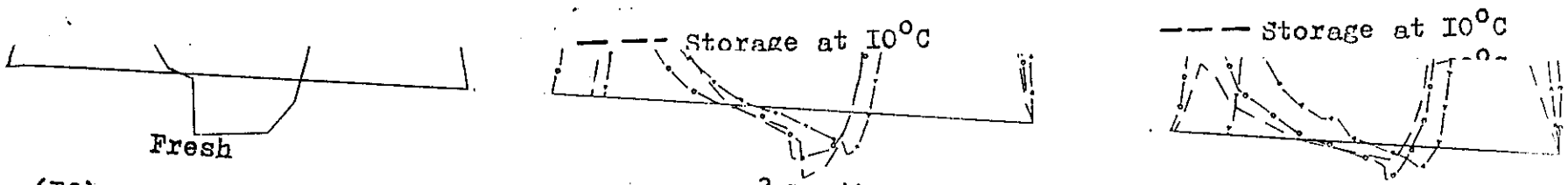
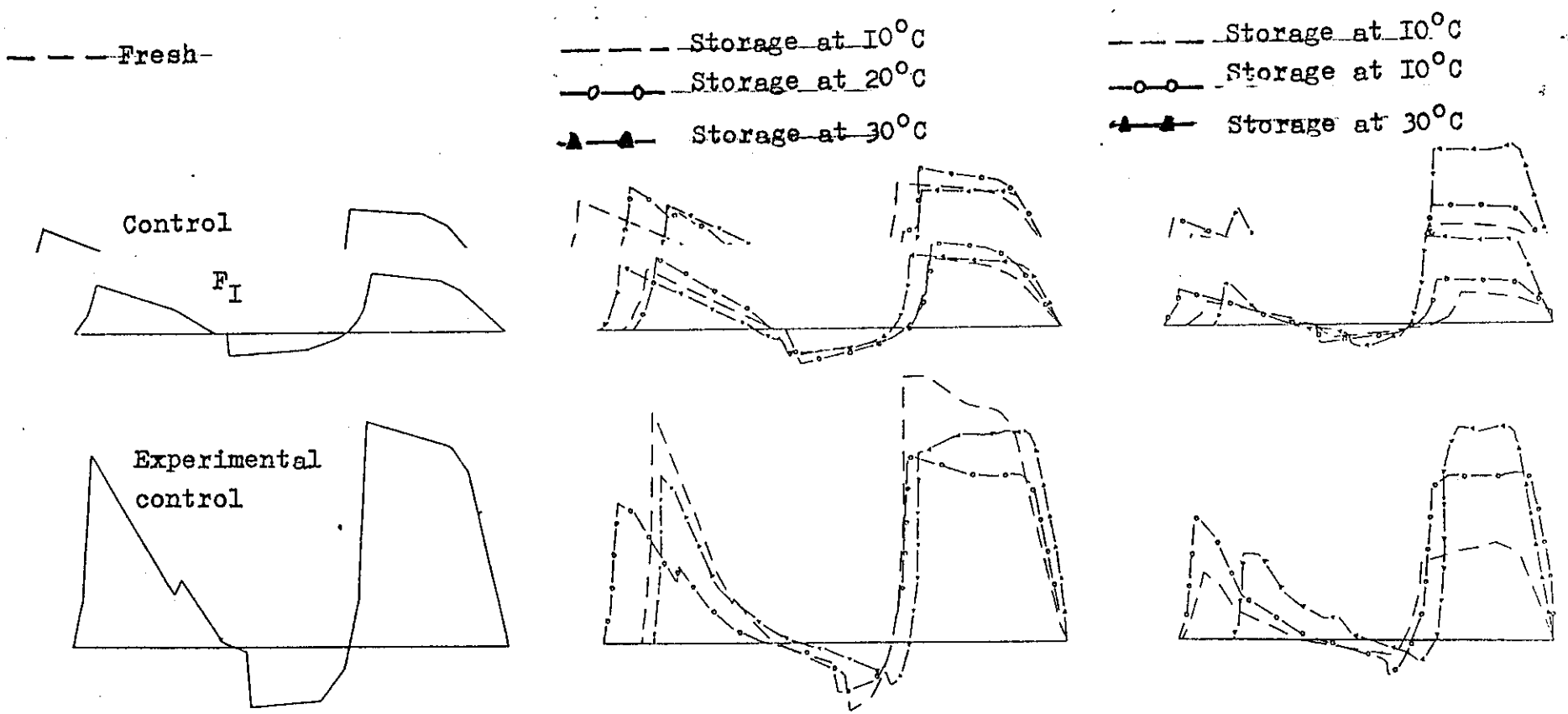


Fig (I9) A typical texture-profile curve obtained by using Instron Testing Machine of processed cheese from different blends (Cheese base I) during storage period at different temperatures.



Fig(20) A typical texture-profile curves obtained by using Instron Testing Machine of processed cheese from different blends(Cheese base II) during storage period at different temperaturs.

Table (67) The hardness of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Fresh	Storage period: 3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
		kg									
Control	0.842	0.973	1.210	3.475	1.890	1.580	2.527	5.370	3.160	2.280	1.656
Using cheese base I:											
A	1.525	1.736	2.157	6.845	3.580	3.054	4.423	7.687	5.050	3.920	2.495
B	2.288	2.183	2.577	7.898	4.220	3.580	4.844	8.108	5.510	4.500	2.565
C	1.841	1.525	1.578	4.949	2.680	2.422	3.475	6.423	4.110	3.170	1.889
D	1.499	1.499	1.815	4.001	2.440	2.527	3.686	6.213	4.140	3.030	1.728
E	0.921	1.184	1.184	3.686	2.020	1.790	2.317	4.423	2.840	2.210	1.356
F	1.236	1.420	1.578	4.739	2.580	2.422	3.054	4.528	3.330	2.710	1.457
Using cheese base II:											
A_1	2.236	2.694	8.316	11.583	7.500	4.949	9.582	8.951	7.830	6.890	3.640
B_1	2.130	2.525	2.893	11.583	5.670	5.265	7.055	11.899	8.070	6.190	4.160
C_1	1.026	1.341	1.341	5.476	2.720	2.422	3.159	6.002	3.860	2.970	2.037
D_1	1.657	1.736	2.525	7.476	3.910	2.948	4.423	7.792	5.050	4.080	2.598
E_1	1.341	1.447	1.841	5.581	2.960	2.948	3.686	6.634	4.420	3.350	2.081
F_1	0.736	0.831	1.026	3.475	1.780	1.474	2.106	4.212	2.600	1.980	1.369
Experimental control	2.709	3.209	8.947	10.425	7.190	4.739	7.898	10.319	7.650	6.750	3.130
Means	1.580	1.730	2.780	6.440	3.650	3.010	4.450	7.040	4.830	3.860	—

Table (68) clearss the statistical dealing with interactions of hardness values of processed cheeses between their storage temperatures and storage time. It's clear that the hardness values increased gradually from fresh up to the 6 months where it showed 1.57, 2.65 and 4.83 when fresh, 3 and 6 months storing period respectively. On the other hand, the interactions of hardness values and storage temperature were also increased at 10° and 20°C while, it showed a higher value of hardness for samples stored at 30°C.

The analysis of variance for hardness of processed cheese made from different blends are illustrated in table (69). It was noticed that the treatments, storage time , storage time x storage temperature showed highly significant results but treatment x storage time was insignificant.

The obtained results are in agreement with the trend of the results obtained by Chen et al (1979) who studied the texture analysis of processed cheese.

Table (60) indicates the correlation coefficient of the hardness values for resultant processed cheese stored at 10°C in correlation with the determined chemical parameters. The total nitrogen indicates the higher correlation value (r = 0.662) than the other chemical parameters. The pH values came in the second order (r = 0.659) that indicates its effective role in the hardness property of processed cheese. The salt can be considered as an effective factor in cheese hardness where, it was in the third position. Depending on the hardness property for evaluating the structure of processed cheese, it must be put in

represented in table (71). The obtained values decreased along the storage period showing 0.5396,0.4289 and 0.3813 Cm when fresh, 3 and 6 months storage. Regarding the storage temperature (10°, 20° and 30°C), the obtained values showed a slight gradual decrease reaching the minimum mean of 0.3062 at 30°C.

The F-test analysis (Table 72) for cohesiveness of processed cheese produced from different blends showed a highly significant values for all sources of variance except treatment x storage time which was recorded as insignificant.

The correlation coefficient between cohesiveness and chemical parameters of processed cheese are shown in table (60). This property was of a high correlation with pH value and salt content. Ash content, total nitrogen and lactose can be come in the second order successively. To take this property in acount for evaluating the physical property of processed cheese, it can be concluded that pH values and salt content play an important role in this respect. The obtained results are confirmed with the "r" values recorded by Chen et al (1979) who gave "r" values of 0.311 and 0.107 for pH and salt in relation with cohesiveness property of processed cheese respectively. They also reported that a textural measures were in close correlation with pH of cheese samples.

C) Gumminess:

Gumminess is expressed as the product of hardness and cohesiveness.

Table (73) illustrates gumminess property of processed cheese made from different blends along the storage period of six

Table (71) Interaction of cohesivness means between storage temperatures and storage time of processed cheese made from different blends.

	Fresh	10 C	20 C	30 C	Means	S.D
Fresh	0.5396	-	-	-	0.5396	0.0932
3 months	–	0.5049	0.4362	0.3455	0.4289	0.1279
6 months	–	0.4683	0.4086	0.2669	0.3813	0.3813
Means	0.5396	0.4866	0.4224	0.3062	0.4243	—
S.D	0.0932	0.1083	0.1261	0.1069	--	--

Table (72) Analysis of variance (F-test) for cohesivness of processed cheese from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	0.6753	0.0519	7.99	**
Storage time	2	0.2649	0.1325	20.38	**
Storage time x storage temp.	4	0.4784	0.1196	18.40	**
Treatment x storage time	26	0.0955	0.0037	0.57	n.f
Residual	52	0.3380	0.0065		
Total	97	1.8522			

months at different temperatures. The obtained results of fresh cheeses from differnt blends cleared a wide range of 0.445 to 1.368 kg for the obtained cheeses. The average of the resultant fresh processed cheese was 0.799 kg. The obtained values are somewhat lower than those recorded by Gupta et al (1984) on evaluating the rheological properties of processed cheese and processed cheese foods. On the other hand, Chen et al (1979) recorded lower values for gumminess property compared with the results in the present study. This can be attributed to the different blends used in their research which differ from that used here.

Statistical analysis of the interactions of gumminess values between storage time and storage temperature of processed cheese from different blends are presented in table (74). The tabulated data cleared that the values increased during the storage period as they were 0.799, 1.279 and 1.587 kg when fresh, 3 and 6 months respectively. The other interactions between gumminess values and the storage temperature were increased gradually giving the maximum value 1.911 kg at 30°C compared with the value of o.799 kg when fresh and 1.067 and 1.321 kg for cheese stored at 10° and 20°C.

The F-test analysis cleared highly significant values for gumminess of processed cheese as affected by treatments, storage time and storage time x storage temperature while treatment x storage time was insignificant (Table 75).

The relationship between gumminess and the chemical parameters of processed cheese "r" values are illustrated in table (76). This property closed correlated with total nitrogen, pH,

Table (76) The correlation coefficient (r) between some physical properties and chemical parameters of processed cheese stored at 10°C.

Test	Gumminess	Sprining	Cheweniss	Adhesiveness	Optical density
pH	- 0.444	0.470	- 0.316	0.517	0.510
T.S	0.436	0.026	0.457	0.175	0.019
Fat	0.390	- 0.154	0.334	- 0.087	0.163
F/DM	- 0.121	- 0.194	- 0.211	- 0.311	0.146
Salt	- 0.048	0.115	- 0.060	- 0.045	- 0.046
Ash	0.207	0.109	0.249	0.173	- 0.051
T.N	0.664	- 0.170	0.668	0.024	0.269
S.N	- 0.032	- 0.173	- 0.092	- 0.328	0.293
S.N/T.N	- 0.134	- 0.143	- 0.193	- 0.322	0.252
Lactose	- 0.150	0.392	- 0.027	0.453	0.312

Table (77) The springing of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Fresh	3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
					cm						
Control	7.5	7.8	7.0	6.5	6.767	6.3	6.9	4.8	6.000	6.543	1.081
Using cheese base I:											
A	7.2	6.7	6.8	7.6	7.033	6.2	6.3	6.8	6.433	6.800	0.486
B	7.2	7.4	6.8	7.0	7.067	5.2	5.6	5.9	5.567	6.443	0.864
C	7.9	8.2	7.2	6.5	7.300	5.6	5.4	5.9	5.967	6.814	0.986
D	6.7	7.2	5.3	5.9	6.133	6.0	6.0	5.9	5.967	6.143	0.616
E	7.1	8.7	6.4	7.0	7.467	6.4	6.6	6.0	6.333	6.929	0.898
F	8.0	7.5	8.1	7.0	7.533	6.1	6.8	5.9	6.267	7.057	0.866
Using cheese base II:											
A_1	5.9	6.7	5.5	5.5	5.900	5.3	4.9	4.9	5.033	5.529	0.626
B_1	7.5	8.0	5.5	5.0	6.167	6.4	5.5	5.5	5.800	6.200	1.146
C_1	6.7	7.0	6.6	5.8	6.467	6.5	6.2	6.2	6.300	6.429	0.395
D_1	6.9	7.8	7.8	6.7	7.433	5.4	6.2	5.1	5.567	6.557	1.066
E_1	6.5	7.3	7.0	6.9	7.067	5.9	6.6	5.8	6.100	6.571	0.559
F_1	6.5	7.1	6.4	7.2	6.900	5.8	6.7	3.6	5.367	6.186	1.232
Experimental control	7.6	6.3	7.7	6.7	6.900	5.9	6.0	6.2	6.033	6.629	0.743
Means	7.09	7.41	6.72	6.47	6.867	5.93	6.19	5.61	5.910	6.488	--

Table (78) Interation of springing means between storage tempertures and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	7.086	-	-	-	7.086	0.592
3 months	-	7.407	6.721	6.471	6.867	0.854
6 months	-	5.929	6.193	5.607	5.910	0.643
Means	7.086	6.668	6.457	6.039	6.488	--
S.D	0.592	0.926	0.762	0.892	--	--

Table (79) Analysis of variance (F-test) for springing of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	13.8310	1.0639	2.65	**
Storage time	2	25.0786	12.5393	31.24	**
Storage time x storage temp.	4	8.9810	2.2452	5.59	**
Treatment x storage time	26	7.7223	0.2970	0.24	n.f
Residual	52	20.8724	0.4014		
Total	97	76.4853			

when fresh and after 3 and 6 months respectively. However, the interaction means of springiness values show the same trend during the storage at different temperatures.

F-test analysis which given in table (79) showing a highly significant for the springiness through the treatments, storage time and storage time x storage temperature. However the treatment x storage time showed insigmificant results.

The correlation coefficient "r" between springing property of processed cheese in relationship with chemical parameters of this cheeses indicated a higher values "r" = 0.470 and 0.392 for pH and lactose respectively. The other chemical parameter cleared a low "r" values with springiness. This means that these parameters have no clear correlation with the studied property (Table 76).

E) Chewiness properity:

Chewiness was described to the panelists as the number of chews required to swallow a certain amount of sample (from tender to tough). it can be measured by the time required to masticate the cheese sample at a constant rate of force application to reduce it to a consistency suitable for swallowing.

Chewiness is expressed mathematically (from the Instron Machine) as the product of gumminess x springiness.

Table (80) clears the results of chewiness property of processed cheese made from different blends along the storage period of six months at 10^{o}, 20^{o} and 30^{o}C. It is obvious that the values of chewiness of fresh block processed cheese ranged from 2.91 to 10.40 kg/Cm with an average of 5.79 kg/Cm. These

values clear that there are great variations; in this respect between the resultant processed cheese. This is due to the different blends used in the manufacture which varied from Cheddar cheese (young and mature) and cheese base with the different ripening degrees. Similar results were recorded by Gupta et al (1984) which confirms our results.

The obtained results of chewiness property for processed cheese stored for 6 months at 10°, 20°and 30°C were statistically analysed where interactions between storage temperature and storage time were recorded in table (81) as this property was increased with the storage development showing 5.78, 8.76 and 9.39 kg/Cm when fresh, 3 and 6 months consecutively. On the other hand, pronounced increase in the interaction values of chewiness property for cheese stored at a different temperatures was observed.

Results was evaluated according to F-test where they shew a highly significant values between treatments, storage time and storage time x storage temperature, while, tratment x storage time show insignificant results (Table 82).

The relationship between the chewiness values of processed cheese and the chemical parameters are presented in table (76). Total nitrogen showed the highest "r" value in connection with chewiness (0.668). Thus indicates the close relationship between chewiness and total nitrogen. Total solids and pH values can be ordered later as effective factors in correlation with chewiness property of processed cheese. However, the other tested chemical parameters have a slight effect on this property as they gave low values. The correlation value of pH was in accordance to the value recorded by Chen et al (1979).

Table (81) Interaction of chewiness means between storage temperture and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	5.78	-	-	-	5.78	2.110
3 months	-	6.06	7.16	13.06	8.76	5.307
6 months	-	7.83	9.81	10.53	9.39	3.504
Mean	5.78	6.941	8.49	11.79	8.60	--
S.D	2.11	2.531	4.66	4.57	--	--

Table (82) Analysis of variance (F-test) for chewiness of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	501.92	38.61	3.03	**
Storage time	2	138.49	69.25	5.44	**
Storage time x storage temp.	4	452.36	113.09	8.88	**
Treatment x storage time	26	99.63	3.83	0.30	n.f
Residual	52	661.95	12.73		
Total	97	1854.35			

F) Adhesiveness property:

Adesiveness is defined as the force required to remove the cheese sample that adheres to the mouth surface. It is described to the panelists as the stickiness of sample in the mouth throughout mastication (from slippery to sticky).

Adesiveness is measured by integrating the area "A_3" in the texture-profile curve (Fig 19 and 20).

Regarding the adhesiveness values of processed cheese table (83) clears that the values of fresh processed cheese ranged from 2.0 to 11.0 kg with an average of 7.39 kg. The obtained values show great variations for processed cheese from different blends, these variations can be refered to the different combinations of ingredients (Cheddar cheese and cheese bases) involved in preparing the blends.

Similar results were reported by Gupta et al (1984) when they studied the rheological properties of commerical processed cheese.

The adhesiveness interactions of resultant processed cheese presented in table (84), showed a slight difference between fresh and 3 months storage period, followed by sharp decrease after 6 months where they were 7.39, 7.95 and 2.81 kg respectively. On the other hand, the interaction of adhesiveness values for processed cheese stored at different temperature showed gradual decrease during the storage at 10°and 20°C compared with the fresh while at 30°C there was a slight increase thereafter.

Table (83) The adhesiveness of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period: Fresh	3 months: 10°C	3 months: 20°C	3 months: 30°C	3 months: Means	6 months: 10°C	6 months: 20°C	6 months: 30°C	6 months: Means	Means	S.D
	kg										
Control	5.0	7.2	8.7	16.0	10.63	2.5	3.0	2.8	2.77	6.46	4.83
Using cheese base I:											
A	7.7	7.5	8.2	11.6	9.10	4.0	3.0	3.8	3.60	6.54	3.09
B	5.8	5.0	9.5	7.6	7.37	1.2	1.5	3.0	1.90	4.80	3.11
C	11.7	10.5	7.3	9.6	9.13	3.0	3.3	1.8	2.70	6.74	4.03
D	9.0	8.0	10.7	8.0	8.90	4.0	3.3	3.0	3.43	6.57	3.08
E	6.3	9.2	8.8	7.6	8.50	3.0	3.2	1.3	2.50	5.63	3.13
F	8.7	8.8	8.0	10.0	9.93	2.2	3.2	5.0	3.47	6.56	3.06
Using cheese base II:											
A_1	2.0	4.8	2.0	2.0	2.93	1.3	2.0	3.0	2.10	2.44	1.15
B_1	8.7	9.2	1.8	2.0	4.33	3.2	2.2	3.2	2.87	4.33	3.21
C_1	7.3	6.8	5.8	8.0	6.87	3.3	1.0	2.8	2.37	5.00	2.64
D_1	9.0	7.8	12.3	7.0	9.03	3.8	2.8	2.0	2.87	6.39	3.72
E_1	7.0	9.2	9.5	14.4	11.03	3.5	3.2	2.5	3.07	7.04	4.34
F_1	4.2	5.0	5.0	10.0	6.67	3.0	2.8	3.8	3.20	4.83	2.44
Experimental control	11.0	7.3	10.0	6.4	7.90	2.0	4.0	1.7	2.57	6.06	3.68
Means	7.39	7.59	7.69	8.59	7.95	2.86	2.75	2.84	2.81	5.67	--

Table (85) clears the analysis of variance for processed cheese adhesiveness where it was highly significant between treatments and storage time. The storage time x storage temperature and treatments x storage time recorded insignificant results.

The correlation coefficient "r" illustrated in table (76) stated that the pH value correlated highly with the adhesiveness property of processed cheese showing "r" value of 0.517. Lactose content, soluble nitrogen and F/DM show "r" values of 0.453, 0.328 and 0.311 respectively. This to clear that these chemical parameters correlated in low connection with the tested property. The rest chemical parameters which gave lower "r" values having the lowest effect with the processed cheese adhesiveness property.

6) Colour determination (expressed as optical density):

Table (86) recorded the optical density of the extracted solution of processed cheese samples which indicate the changes in the colour of processed cheese manufactured from different blends along the storage period of 6 months at 10°, 20° and 30°C. The obtained values of fresh cheese ranged from 0.84 to 1.16 with an average of 0.98. It was noticed that there is a variation between cheese samples made from different blends. These variations can be attributed to the browning in colour through "Mailard" reaction between the aldhyde group of lactose or the monosaccharides and the amine groups of proteins during heating (Nickerson, 1965 and Hall and Hedrich, 1971). Moreover, the processing conditions such as the duration or the holding time or the variation in different blends can also play as important factor in inducing some variation in the optical density as a measure of

Table (86) The obtical density (O.D) of processed cheese colour made from different blends during storage period at different temperatures and mean values.

Blends	Fresh	Storage period: 3 months				6 months				Means	S.D
		10°C	20°C	30°C	Means	10°C	20°C	30°C	Means		
Control	1.16	1.02	0.86	1.08	0.987	1.14	1.32	1.01	1.157	1.084	0.1440
Using cheese base I:											
A	0.84	1.08	1.04	1.24	1.120	1.16	1.26	1.04	1.153	1.094	0.1436
B	0.92	1.06	1.04	1.22	1.107	1.26	1.24	1.08	1.193	1.117	0.1262
C	0.93	0.88	1.04	1.14	1.020	1.28	1.12	1.12	1.173	1.073	0.1357
D	0.85	1.04	0.88	1.12	1.013	0.86	1.04	1.10	1.000	0.984	0.1172
E	0.95	0.92	0.86	1.08	0.953	1.20	1.10	1.04	1.113	1.021	0.1178
F	1.02	1.02	0.90	1.10	1.007	1.18	1.14	1.06	1.127	1.060	0.0924
Using cheese base II:											
A_1	1.14	1.00	1.04	1.28	1.107	1.32	1.26	1.32	1.300	1.194	0.1340
B_1	1.08	1.08	1.06	1.30	1.150	1.30	1.32	1.19	1.270	1.191	0.1154
C_1	0.99	0.92	1.26	1.26	1.147	1.34	1.26	1.25	1.263	1.174	0.1574
D_1	0.96	0.76	1.14	1.17	1.023	1.28	1.06	1.21	1.183	1.083	0.1759
E_1	0.90	1.04	1.16	1.17	1.123	1.12	1.04	1.03	1.063	1.066	0.0938
F_1	0.98	0.84	1.08	1.18	1.033	0.98	0.94	1.15	1.023	1.021	0.1212
Experimental control	1.00	1.06	0.96	1.27	1.097	1.24	1.30	1.36	1.300	1.170	0.1597
Means	0.98	0.98	1.02	1.19	1.063	1.19	1.17	1.14	1.166	1.095	—

the cheese colour. In addition, a slight variation of pH values of the obtained processed cheese can be of great effect in this respect.

The interactions of the optical density values as a measurment for colour variation of processed cheese stored for 6 months at different temperatures are illustrated in table (87). The interactions show slight increase during the storage period up to 6 months. On the other hand, the interactions increased slightly at different storage temperatures reaching the maximum for samples stored at the higher temperature 30°C (O.D, 1.16) compared with the fresh samples (O.D, 0.98). The increase in colour of cheese stored at high temperature is due to the formation of melanoidine substances as a result of "Maillard" reaction (browning reaction). The same findings was stated by Thomas (1977) and Ibrahim (1982). Moreover, it was reported that the colour of the processed cheese increased with the increase of lactose content due to the more melanoidine formation. This was confirmed by the high correlation coefficient existed between the lactose content and the optical density of the cheese colour (r = 0.312).

The F-test of optical density for processed cheese made from different blends are present in table (88). These were highly significant between treatments, storage time, storage time x storage temperature while treatment x storage time showed insignificant results.

Table (76) clears the correlation coefficient values between the optical density of the cheese colour as affected by the chemical composition of the resultant processed cheese. It is

Table (87) Interaction of obtical density (O.D) colour means between storage temperatures and storage time of processed cheese made from different blends.

	Fresh	10°C	20°C	30°C	Means	S.D
Fresh	0.98	-	-	-	0.9800	0.0962
3 months	-	0.98	1.0236	1.1864	1.0633	0.1328
6 months	-	1.19	1.1714	1.1357	1.1657	0.1217
Mean	0.98	1.085	1.0957	1.1611	1.0953	—
S.D	0.0962	0.158	0.1413	0.0952	—	—

Table (88) Analysis of variance (F-test) for obtical density (O.D) colour of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	0.4023	0.0308	3.24	**
Storage time	2	0.4373	0.2186	25.00	**
Storage time x storage temp.	4	0.3528	0.0882	10.08	**
Treatment x storage time	26	0.2416	0.0093	1.06	n.f
Residual	52	0.4548	0.0087		
Total	97	1.8888			

obvious that the pH value correlates closely with the incidence of colour in cheese samples where the "r" value was 0.510. The lactose content seems to play an important role in cheese browning, therefore, it shows somewhat higher "r" value (0.312). The "r" values of S.N and T.N came later as an effective factors in cheese colouring where they recorded "r" value 0.293 and 0.269 respectively. The other chemical parameters which show low values have no noticeable effect on the changes of cheese colour.

IV- Sensory Evaluation:

It is certainly true that an objective method can never excluding replace the sensory evaluation of food texture, but it does effer the opportunity of recording in an unbased manner the physical condition of a sample for future reference. Because of its dependence upon the reproducibility of standard reference materials and variable errors, the sensory method lacks absolute quality, a lack that is characteristic of any procedure relying on individual experience.

Table (89) and figs (21, 22 and 23) show the scores of block. processed cheese the evaluations which were made from different bleends which stored at $10^{o}C$ for fresh, 3 and 6 months storage period. The fresh cheese from different blends received variable over all points. The fresh cheese manufactured from blends B_1, C_1, A_1, control, B and E_1 obtained the higher evaluation points 13.5, 13.5, 13.4, 13.1, 12.8 and 12.8 respectively. The cheeses manufactured from blends B_1, C_1 and E_1 were mainly made from cheese base II with different combinations of young and mature Cheddar cheese. Within the cheeses of the higher score were processed cheese manufactured from mature Cheddar cheese of different ripening period.

Table (89) The organoleptic evaluation of processed cheese made from different blends during storage period at different temperatures and mean values.

Blends	Storage period: Fresh				3 months				6 months				Means	S.D
	Appearance 4	Texture 8	Flavour 8	Overall 20	Appearance 4	Texture 8	Flavour 8	Overall 20	Appearance 4	Texture 8	Flavour 8	Overall 20	20	
Control	3.1	5.8	4.6	13.5	2.9	5.0	4.6	12.5	3.3	5.2	3.2	11.7	12.43	3.954
Using cheese base I:														
A	3.0	6.0	4.4	13.4	3.3	5.2	4.2	12.7	3.3	5.0	4.8	13.1	13.07	2.864
B	2.8	5.2	4.8	12.8	2.9	5.0	4.4	12.3	3.4	5.0	3.6	12.0	12.37	2.918
C	2.5	4.6	4.2	11.3	3.2	5.0	4.4	12.6	3.4	4.8	4.0	12.2	12.03	2.965
D	2.9	5.0	3.8	11.7	3.1	5.2	3.6	11.9	3.5	5.0	3.4	11.9	11.83	2.640
E	2.4	4.0	3.4	9.8	3.1	5.4	5.0	13.5	3.0	4.4	4.2	11.6	11.63	4.674
F	2.9	4.8	4.2	11.9	3.2	5.8	5.2	14.2	2.9	3.4	0.6	6.9	11.00	4.379
Using cheese base II:														
A_1	2.5	4.8	3.2	10.5	2.7	3.8	2.3	8.8	2.5	2.4	1.4	6.3	8.53	3.627
B_1	3.1	6.0	4.4	13.5	3.4	4.8	3.2	11.4	3.5	4.6	4.0	12.1	12.33	3.527
C_1	3.1	4.8	5.6	13.5	3.4	5.8	4.8	14.0	3.2	6.0	5.6	14.8	14.10	3.614
D_1	3.1	5.4	3.6	12.1	3.3	6.0	5.0	14.3	3.3	4.8	3.6	11.7	12.70	2.781
E_1	3.0	5.6	4.2	12.8	3.2	4.4	4.4	12.0	3.4	5.8	5.2	14.4	13.07	3.258
F_1	2.9	5.0	4.2	12.1	3.1	5.0	5.6	13.7	3.4	5.0	4.6	13.0	12.93	4.185
Experimental control	3.2	4.8	4.2	12.2	3.2	4.6	3.2	11.0	3.4	3.8	3.6	10.8	11.33	3.055
Means	2.9	5.1	4.2	12.2	3.1	5.1	4.3	12.5	3.3	4.7	3.7	11.61		

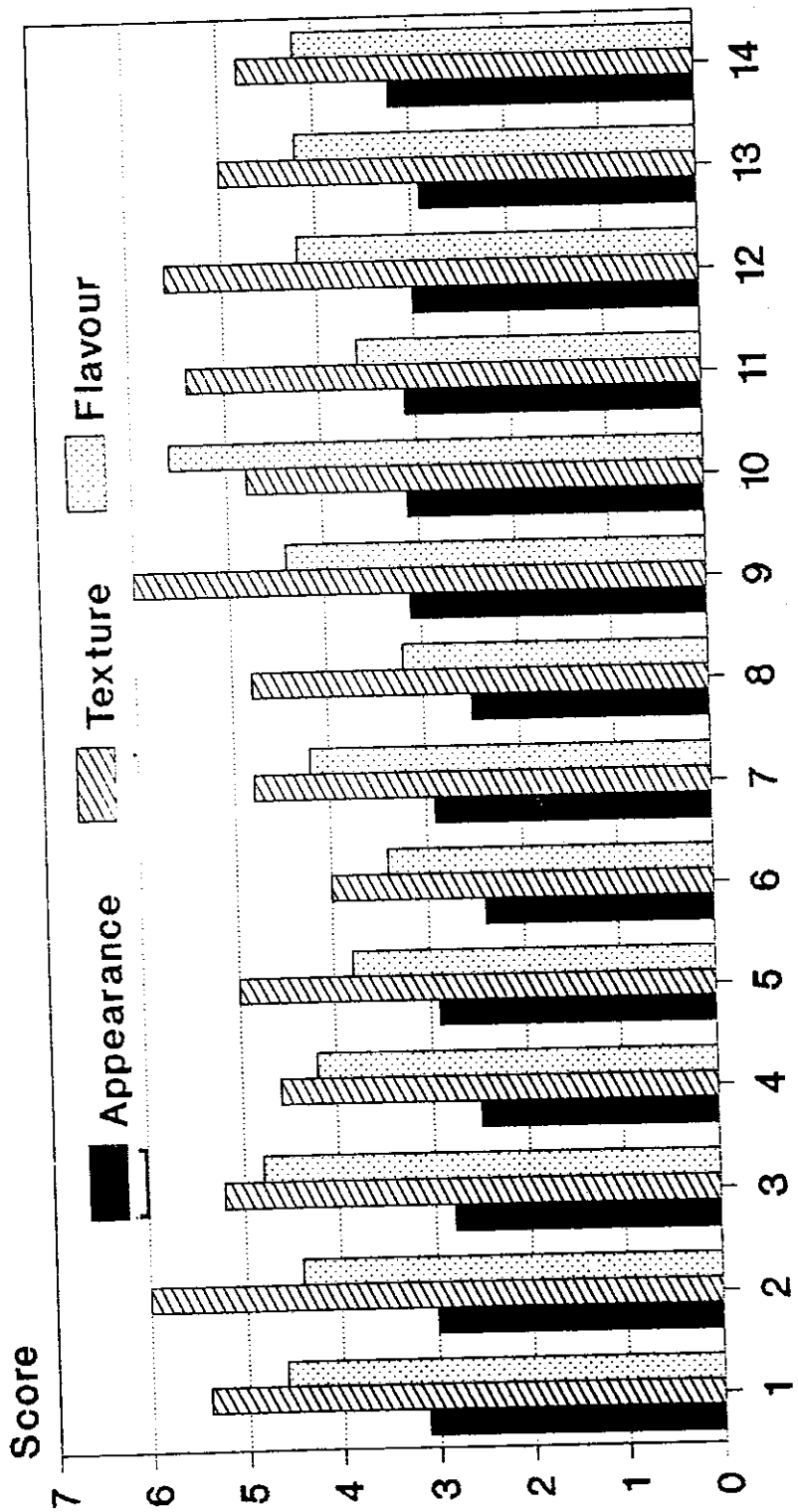


Fig (21) Organoleptic evaluation of fresh processed cheese made from different blends (14 samples).

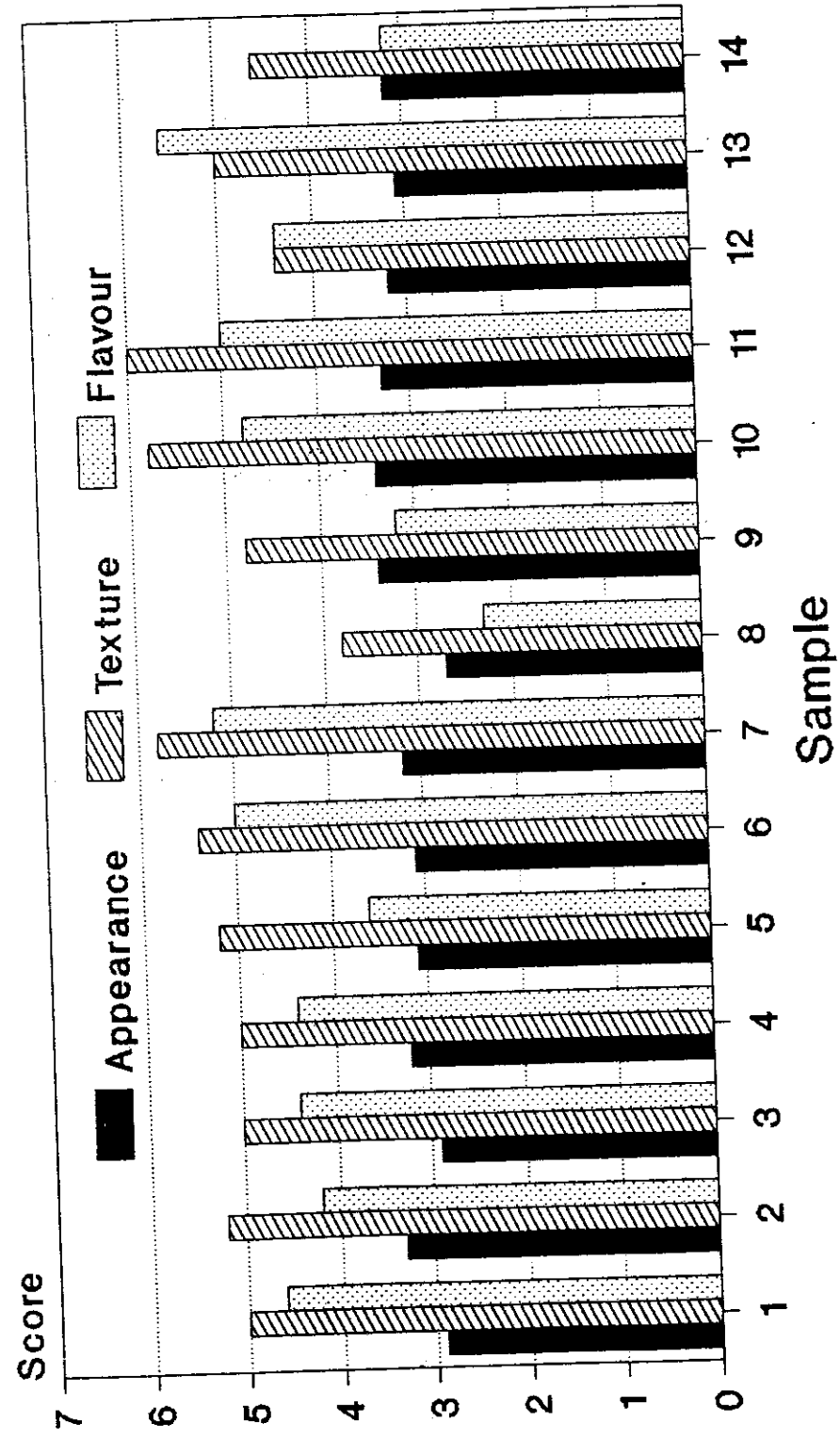


Fig (22) Organoleptic evaluation of processed cheese made from different blends stored at 10°C for 3 months (14 samples).

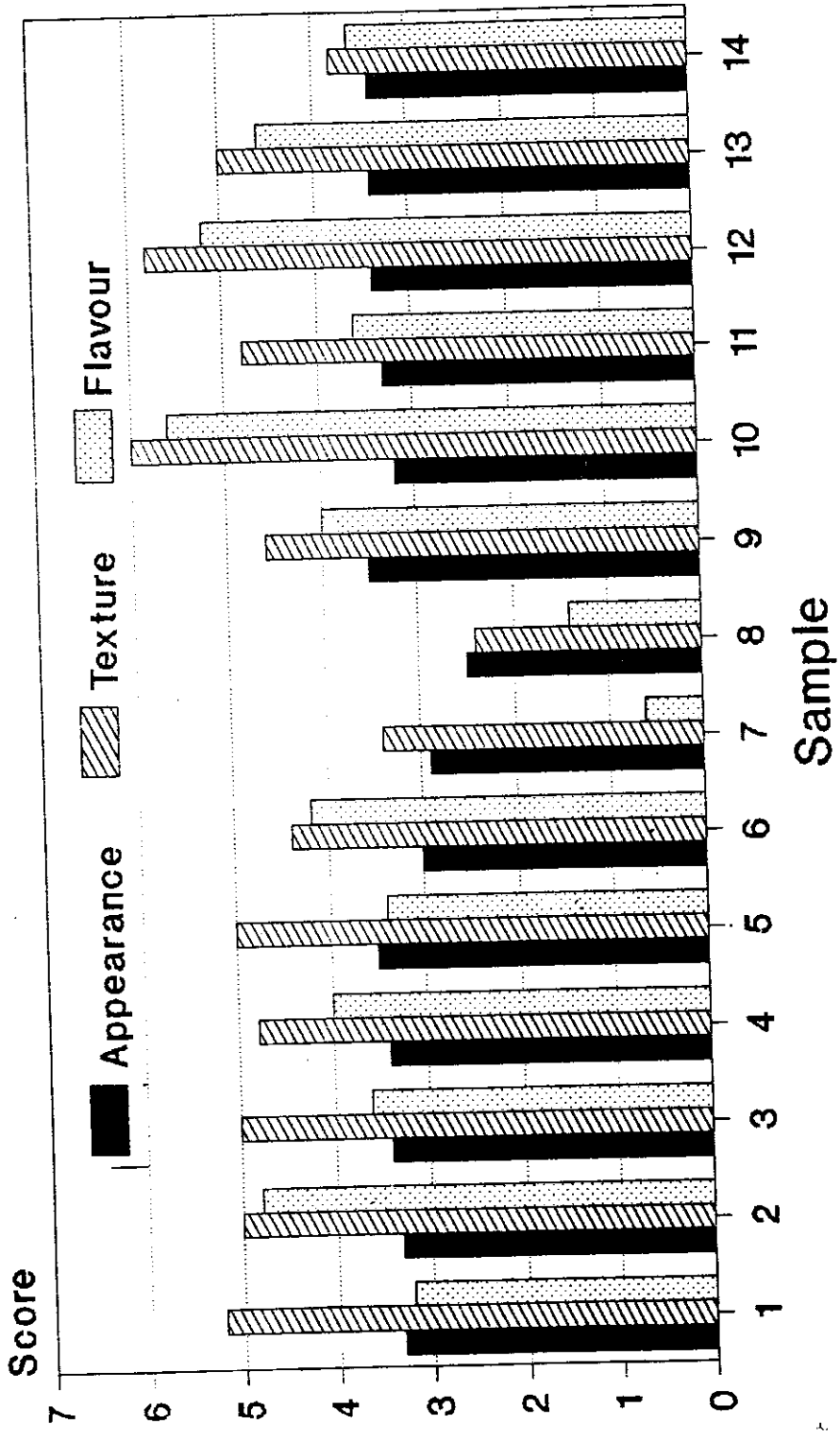


Fig (23) Organoleptic evaluation of processed cheese made from different blends stored at 10°C for 6 months (14 samples).

The blends "A" and "B" involving ≥50 % cheese base I were ordered also through cheeses of higher score. Cheeses made from the other blends having score less than 12.8 points were accepted by the score panels and can be classified as a good quality according to the English graders.

Table (89) and fig (22) show the score points after the evaluation of the resultant processed cheese stored at 10°C for 3 months. Generally, the organoleptic properties of these cheeses did not differ than the fresh as they obtained somewhat higher in the overall score mean points. Prolonging the storage period up to 6 months, the organoleptic properties achieved a slight decrease in the over all mean values of processed cheese manufactured from different combinations of young and mature Cheddar cheese, cheese base I and cheese base II. Processed cheese manufactured from blends C_1, E_1, A and F_1 obtained higher score points being 14.1, 13.07, 13.07 and 12.93 respectively. These blends were mainly contained cheese base I or cheese base II to replace young or mature Cheddar cheese while they were evaluated with a higher score points more than processed cheese manufactured from natural Cheddar cheese (control) which gained 12.43 score points. By other mean it can be concluded that cheese base I and II can replace partially (to a level of 75 %) young and mature Cheddar cheese with sucessful reslts.

Moreover, satistical analysis proved that the composition of the blend had highly significant effect on appearance, body and texture, flavour and the total organoleptic scores of the resultant processed cheese. The storage time had an observed

effect on the appearance and flavour, while there was no apparent effect on the body or the over all scores of the cheese. In addition, the interaction between the compsition of the blends and the storage time had highly significant effect on the organoleptic properties of the processed cheese (Table 90, 91, 92 and 93).

The data are in accordance with those given by Gouda (1980)

Statistical correlation of sensory and objective data was not attempted because a common sample was not included in each panel session, and with these constraints variation between panels could not be estimated. Gupta et al (1984) reported the same results indicating that confounding factors prevent observation of a simple correlation for these factors.

It was noticed that the resultant processed cheese from all blends show a good keeping quality along the six months storage period at 10°C where no noticeable defects were detected.

Table (90) Analysis of variance (F-test) for appearance score of processed cheese made from different blends.

Score of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	15.5238	1.1941	2.99	**
Storage time	2	9.4048	4.7024	11.79	**
Treatment x storage time	26	8.0619	0.3101	0.79	n.f
Residual	369	147.5809	0.3999		
Total	419	310.1905			

Table (91) Analysis of variance (F-test) for body and texture score of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	94.362	7.259	2.88	**
Storage time	2	17.200	8.600	3.41	n.f
Treatment x storage time	26	103.067	3.964	1.57	n.f
Residual	369	930.895	2.523		
Total	419	1386.629			

Table (92) Analysis of variance (F-test) for flavour score of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	202.279	15.560	5.42	**
Storage time	2	27.576	13.788	4.80	*
Treatment x storage time	26	188.357	7.245	2.52	**
Residual	369	1059.050	2.870		
Total	419	1591.512			

Table (93) Analysis of variance (F-test) for overall score of processed cheese made from different blends.

Source of variance	d.f	S.S	M.S	V.r	Sign.
Treatment	13	659.164	50.705	5.33	**
Storage time	2	56.816	28.410	2.99	n.f
Treatment x storage time	26	529.114	20.351	2.14	**
Residual	369	3510.021	9.512		
Total	419	5674.998			