RESULTS AND DISCUSSION

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1. General Composition of guar seeds:

The thickening agents play a paramount role in many industries especially in food industry. So, attention is concentrated nowadays on the organic sources which are represent in crop seeds, see weeds, and plant secretions.

OF those which draw attention is the guar gum *Cyamposis tetragonoloba* due to its high potentially in this respect. Although this crop has a wide spread production in many countries as it was introduced in different varstiel industries, while, in Egypt it did not find the sufficient importance, which may be due to the unadequet know how of its composition, and its uses in food products.

To overcome this absent knowledge ; it is of great important to study the chemical composition of the seeds and to compare with other seeds from the same family, fractionate and identify its components to get aware of properties to private the way in food products.

The study showed that guar seeds were more rich in protein content than other seeds from the same family i.e. mung beans, faba beans and lentlis .

Table(1): The chemical composition of guar seeds,

Composition (dry basis) %	Guar seeds
Moisture	10.43
Crude Protein(N 6.25)	33.80
Crude Fat %	3.92
Carbohydrates %	36.09
Ash %	4.90
Fiber	9.5

of individual mineral constituents is shown in table (5).

Table (5): Analysis of the ash from the guar gum(mg/100 g).

	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	Fe^{+3}	Zn^{+2}	Cu^{+2}
Guar gum extracted with water	23.02	5.42	42.2	76.0	2.4	3.4	5.3
Guar gum extracted with 0.2% NaOH	-	16.3	39.5	68.09	7.4	-	4.90
Guar gum extracted with 1.5% acetic acid.	19.38	12.9	86.0	67.0	3.3	4.02	4.48

From these results, it could be observed that sodium and potassium constituted the major element in the ash of all samples. On the other hand, copper, iron and zinc were present in very minute quantities, also, all samples were free from lead. Korshom, 1988

In general, the content of elements (especially heavy metals) in all samples investigated was lower than that found in some American commercial polysaccharides, which contained (in mg/100g) the following elements: Lead (0.3-1), copper (4-100), calcium (30-2800), mangesium (60-1800) and potassium (1-3900) according to Joseph (1955). Therefore, according to the above results, regarding the mineral constituents the guar gum (

Amino acid Identification:

Guar seeds that previously indicated are higher in protein content than the other seeds from fabacea family. This high percentage of crude protein (43.6%) was reflected on its content of amino acid. As shown from results in table (3) guar seed contain all the essential amino acid and its was in high percentage than in the faba, mung, and lentlis seed. Guar seed contain higher value of glutamic acid being 1946.2 mg/100 g., followed by aspartic acid 1123, serine 713 arginine 679.5, tryptophan 590, leucine 480, glycine 440, alanine 423; lycine 3965, therionine 366 , phynylalanine 364, tyrosine 360, hystidine 354, proline 233,7, Valine 187 and methionine 108.85 mg/100 mg of seeds on dry weight basis. These results were in agreement with those of Smith et al (1959) and Vanthen et al(1961). They found that guar seed contain glutamic acid in percentage of 61% and aspartic acid 30.9%, leucine 17%, glycine 15.4%, serine 14.85%. It is worthy to notice that the amino acids, glutamic, aspartic acid, leucine, glycine, and cerine, constituted more than 50 percent of the total amino acid. From these results it could be concluded that the guar seed protein could be considered as a rich source for the essential amino acids as they were higher than those required.

Table(3): Amino acid content in guar seed.

Amino acids	mg/100 gm on dry basis
Aspartic	1123.62
Threonine	366.23
Serine	713.65
Glutamic	1946.2
Proline	233.77
Glycine	440.6
Alanine	423.9
Valine	187.7
Methionine	108.85
Isoleucine	231.3
Leucine	480.36
Tyrosine	360.1
Phenylalanine	364.9
Histidine	354.2
Lysine	396.5
Arginine	679.5

Terptophan 590.8 mg/100 dry

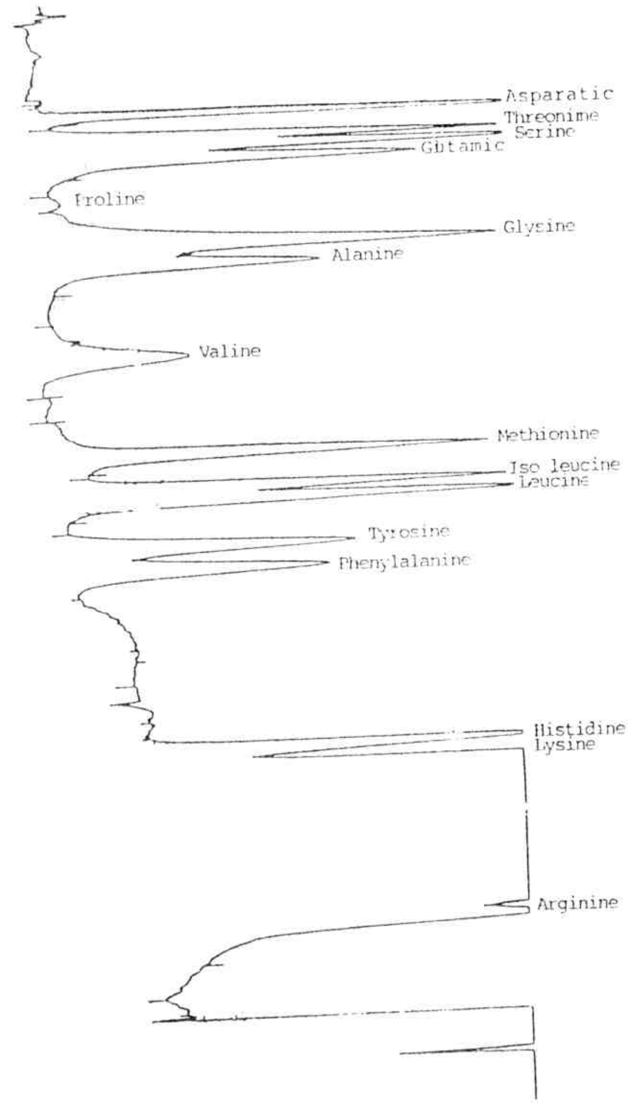

Fig.(1): Standard amino acids.

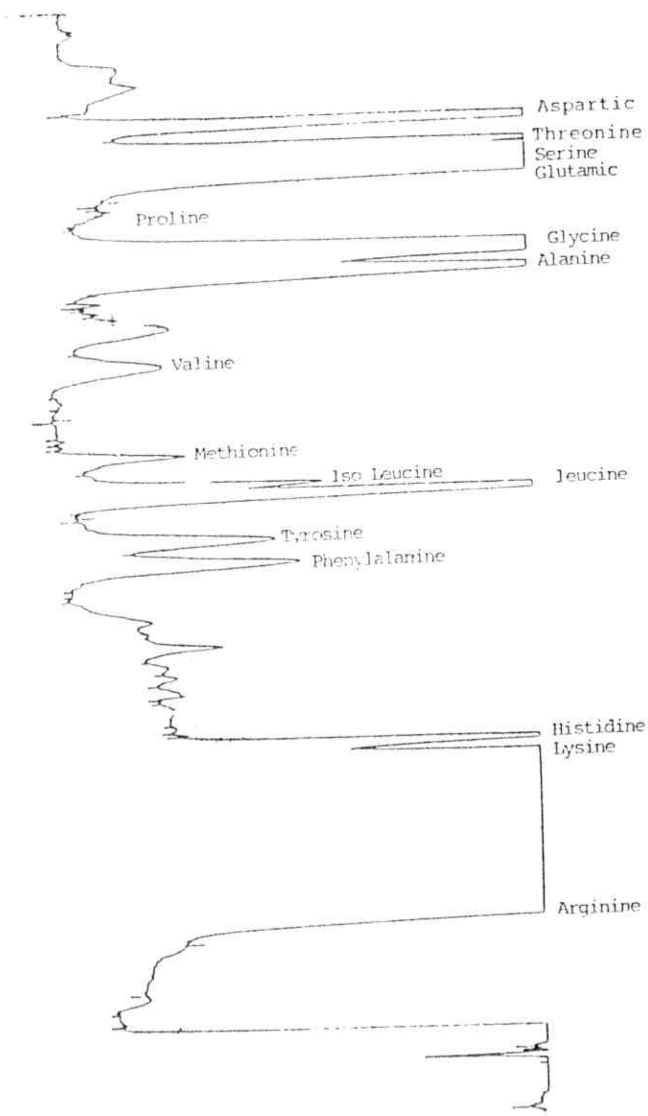

Fig.(2): Amino acid in guar seed.

2. CHEMICAL IDENTIFICATION OF GUAR GUM

2.1. Extraction Process:

To identify gaur gum, it was extracted and purified. The yield of quaran was extracted by versatile process i.e. cold water, hot water, and alkali aqueous treatment (0.2 NaoH), and acid treatment (1.5 acetic acid). The yield extract was 17.5%, 15.5%,9.77 and 7.11% respectively(Table 4).

The above results showed that; the extraction of this polymer by cold water gave the highest amount 17.15%; while hot water gave 15.5% which may be due to the partial effect of temperature on guaran gum. On the other hand, the extraction with acid gave the lowest amount (7.11%).

This observation might be attributed to the partial degradtion of this polysaccharide, resulting from both acid and alkali treatments. Alkali treatment leads to the conversion of aldehydic terminal unit to ketose rearrangement; followed by isosaccharic acid formation. Aspinall(1982) explained this process as very important for the polysaccharide containing 3- linked main chains and 4 linked glycans.

Table(4): Yield percentage of guaran as affected by extraction process.

Extraction process by	Yield percentage
Extraction by cold water	17.15
Extraction by a hot water	15.5
Extraction by alkali aqueous treatment	9.77
Extraction by acid treatment	7.11

Jackman (1983) suggested the following mechanism of acid degradation; and consequently the low yeild extract.

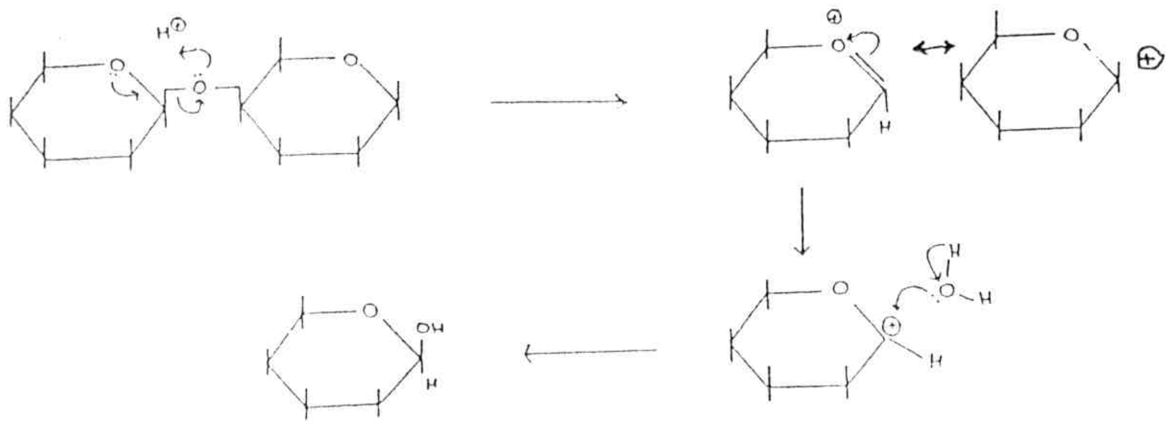

Fig.(6) Mechanism of the effect of acid treatment on polysaccaride molecules, Jackman(1983).

This process leads to the shortening of polysaccharide chain and hence lowers the yield of this polymer.So awareness should be taken during the extraction of the polysaccaride under alkali and acid treatments.

2.2. DETERMINATION OF MOLECULAR WEIGHT

2.2.1. By intrinsic viscosity

Molecular weight is one of the most important factors affecting guar and other thickenning agents(i.e. pectin, C.M.C. and arabic gum). It has a marked influence on Jelly grade. The determination of molecular weight give an indication about the extend of degradation of these polymers(Smit and Bryant,1967).

In the present work the average molecular weight of guar gum sample was calculated by a modificant procedure described by christensen(1954) using an Ostwald-Cannon Fenske pipette. The guar gum sample was compared with standard citrus pectin(which was supplied from high Bulmer Limited Company,U.K.). The results of viscosity measurement are shown in table (5) and Fig.(7). From this figure the intrinsic viscosities (η_1) for standard citrus pectin and guar gum were obtained. The molecular weigh were calculated according to the relation between the molecular weight and intrinsic viscosity as started by Christensen (1954) and applied by many investigators (Smit and Bryant , (1967).

Table (5): Viscosity measurements for standard citrus pectin (C.P.) and guar polysaccharide (G.P.) at pH 6.5 and temperature 25 (in phosphate buffer).

Concentration g/dil. litre	t_o solvent flowtime (seconds)	t flow time in seconds		η_r relative viscosity		$\eta_{r/c}$		η_{sp} specific viscosity		$\eta_{sp/c}$ intrinsic viscosity	
		C.P.	G.P.	C.P.	G.P.	C.P.	G.P.	C.P.	G.P.	C.P.	G.P.
0.20	34	61.8	122.5	1.82	3.60	9.09	18.00	0.818	2.603	4.09	13.01
0.16	34	55.9	103.7	1.64	3.04	10.28	19.00	0.643	2.050	4.02	12.81
0.15	34	53.5	97.5	1.57	2.87	10.49	19.13	0.574	1.86	3.82	12.45
0.1	34	46.65	74.5	1.37	2.19	13.72	21.91	0.372	1.191	3.72	11.91
0.075	34	43.5	64.0	1.28	1.88	17.06	25.07	0.274	0.882	3.65	11.76

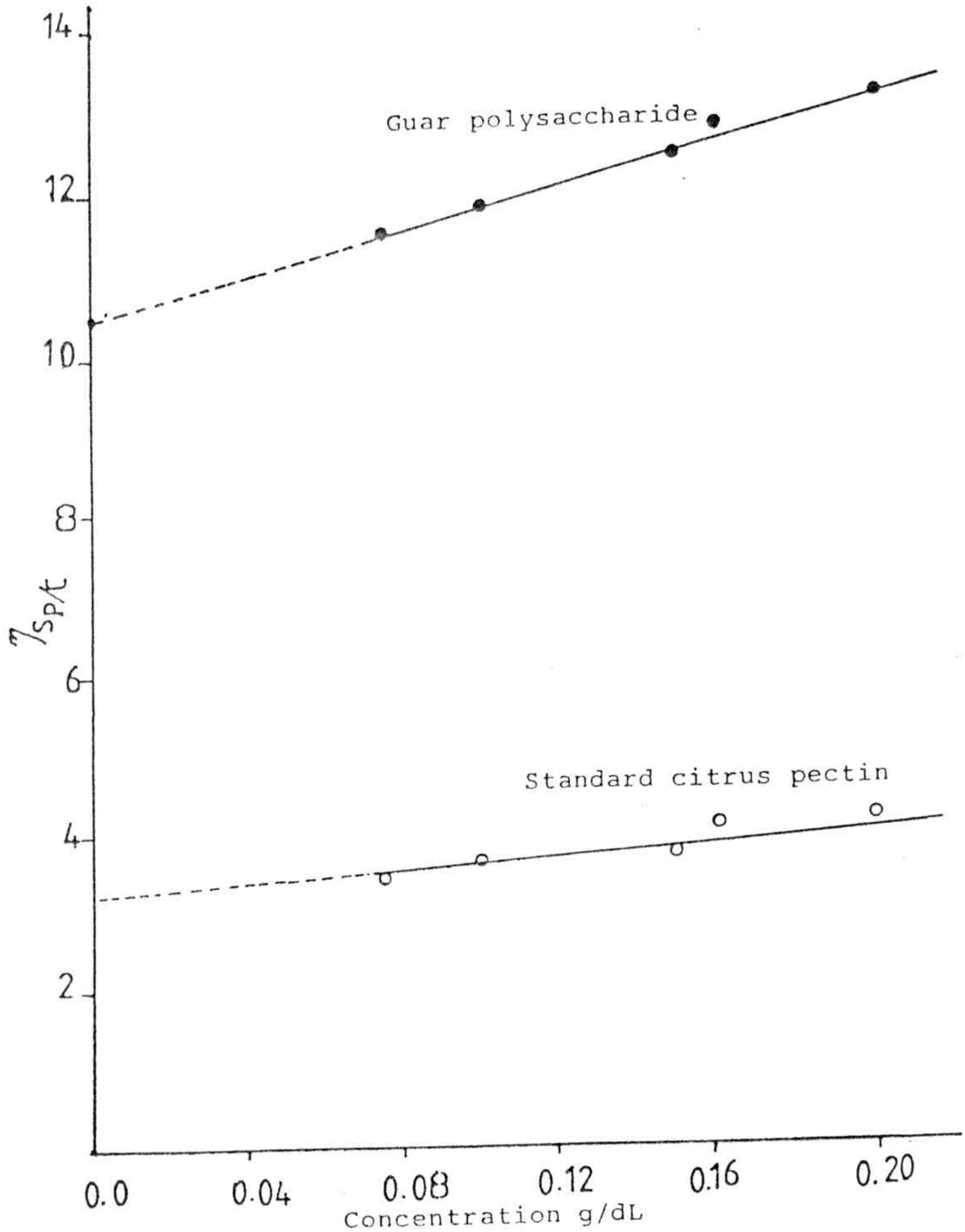

Fig.(7): Intrinsic viscosity of guar polysaccharide and standard citrus pectin.

The results are shown in the following lines:

Sample	Intrinsic viscosity	Average of Molecular weight
Standard citrus pectin	3.35	71.276×10^3
Guar gum	10.38	220.853×10^3

From the above results; it appears that ; the average molecualr weight of the standard citrus pectin is in agreement with that reported by Saad(1985). On the other hand, the results obtained of the average molecular weight of guar gum is in good agreement with that stated by Hoyt(1966), who mentioned that the molecular weight of guar gum has been estimated to be about 220.000.

2.2.2. By periodate Oxidtion:

As the assignment of molecular weight by intrinsic viscosity is not sufficient to calculate the molecular weight. So chemical method(Periodate Oxidation) process was carried out on the basis that periodate oxidation will librate formaldehyde for each anhydroglycose unit in the molecule of polysaccaride. The number of anhydroglycose units which produce one mole of formaldehyde with periodate oxidation was found to equal 1029 aldose units. In the guaran polysaccharide; the average molecular weight was (166.650).

It is important to mention that, the molecular weight given by physical method (Viscosity method) was higher than that determined by the chemical method((periodate oxidation). The ratio of molecular weight for both method was (1.33: 10) repsectively. Such results were agreed by Tawfik(1978) who found that the ratio of molecular weight determined by the physical method(Viscosity method) to that determined by the chemical method) Periodate oxidation7.2:1 in native potato starch while it was 13.6:1 in corn starch. He explained his findings that the amount of formaldehyde released is proportional to the number of reducing end, while the molecular weight determined by the physical method

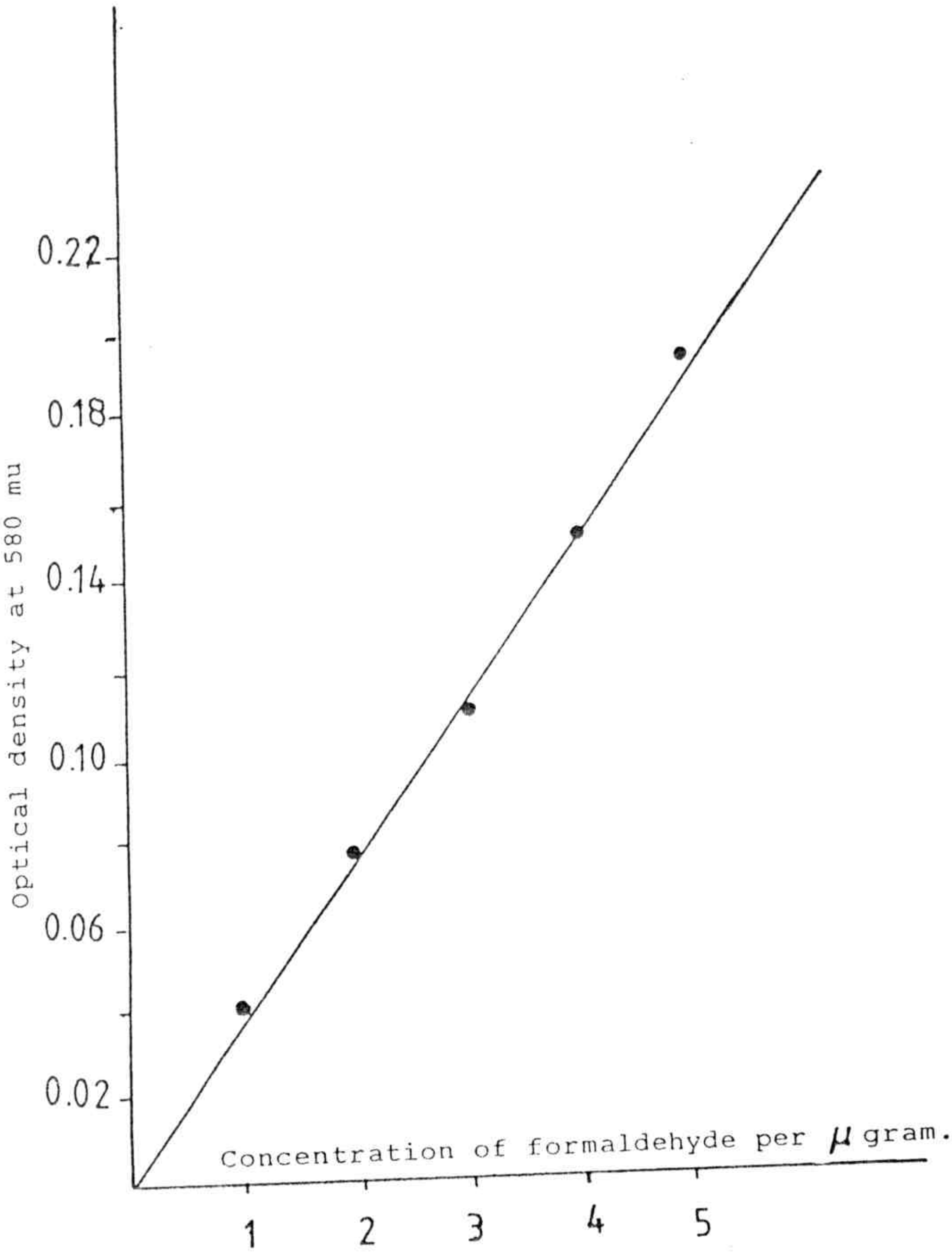

Fig. (8): Standard curve for determinaton of liberated formaldehyde.

(intrinsic viscosity-molecular weight relation) is an indication of molecular size of the whole polysaccharide.This difference in the value of the molecular weight given by physical and chemical methods could be interpreted on the fact that the polysaccharide molecule consists of mixture of a wide range of different fragments of different molecular weights. Each fragment contains a reducing endwhich release a molecule of formaldhyde by periodate oxidation.

The amount of formic acid per anhydroglycose unit (0.05/162) which was liberated from periodate of the polysaccharide was determined by titration method solution of NaoH (0.01N). This amount was 0.167 M per anhydro unit. Since the determined molecular weight was 166.650, the total amount of formic acid which liberate from a molecular of guaran polysaccharide equals about 172 moles $(\frac{166.650}{162} \times 0.167)$. Also the consumed moles of periodate per anhydroglycose unit $(\frac{0.05}{162})$was calculated. This result indicated that each mole of anhydroglycosyl unit consumed 1.168 mole of sodium metaperiodate. Furthermore galactose and mannose unit were not detected after periodate oxidation, and sulphuric acid(1N).

As it is known ;that formic acid molecules are liberated from terminal units, each mole of formic acid is produced per non reducing terminal unit in case of (1 - 4)glycosidic linkages. The results obtained indicate that the guar polysaccharide has a branched structure with 16.7% of the units in terminal position. Besides, the ratio of consumed periodate to an anhydro-glycosyl unit was 1.168:1 shows that the majority of the mannopyranose or galactopyranose were linked through C_1 and C_4. The excess consumed periodate than one (0.168) was applied to produce formic acid from terminal units.(Korshom, 1988)

Since the molecular weight of guar gum was equivalent to 1028 anhydroglycosyl units; therefore; this polysaccharide contains about 171 repeating segments. Fig.(9) illustrates the proposed structure formula for the guar polysaccharide which fit well with the molar ratio of galactose and mannose (1:2) and the results of periodate oxidationa and other analysis.

2.3. ACID HYDROLYSIS OF POLYSACCHARIDE AND IDENTIFICATION OF THE HYDROLYZATE:

The pure polysaccharide of seeds was hydrolysed using N sulphuric acid; then cations and anions were removed using cationic and anionic resins. G.L.C. technique was utilized to fractionate the silyl derivatives of the simple sugars of the hydrolyzate. The results indicated that guar polysaccharide consists of two component only identified as D(+) mannose and D(+) galactose, while mung beans and Faba beans were found to comprise ... arabinose, glucose, fructose and succrose. On the other hand, lentlis was found to exceed those by ribose and xylose.

As shown in Fig.(10a) the results showed that the ratio of galactose residues to mannose monomers in guar polysaccharide were 1:2 according to the total area of the peaks and the area of the each peak in Fig.(10 b). Such results are in agreement with those obtained by Smith, and Montgomery(1959), McCleary (1976), Dey (1978) and Tewari (1984).

Results in table (6) also shown that guar did not contain any other sugar, whilest, faba beans, lentlis, and mung beans contains; glucose, fructose, sucrose, beside arbinose. Lentlis only showed to contain ribose and xylose(Fig.12).

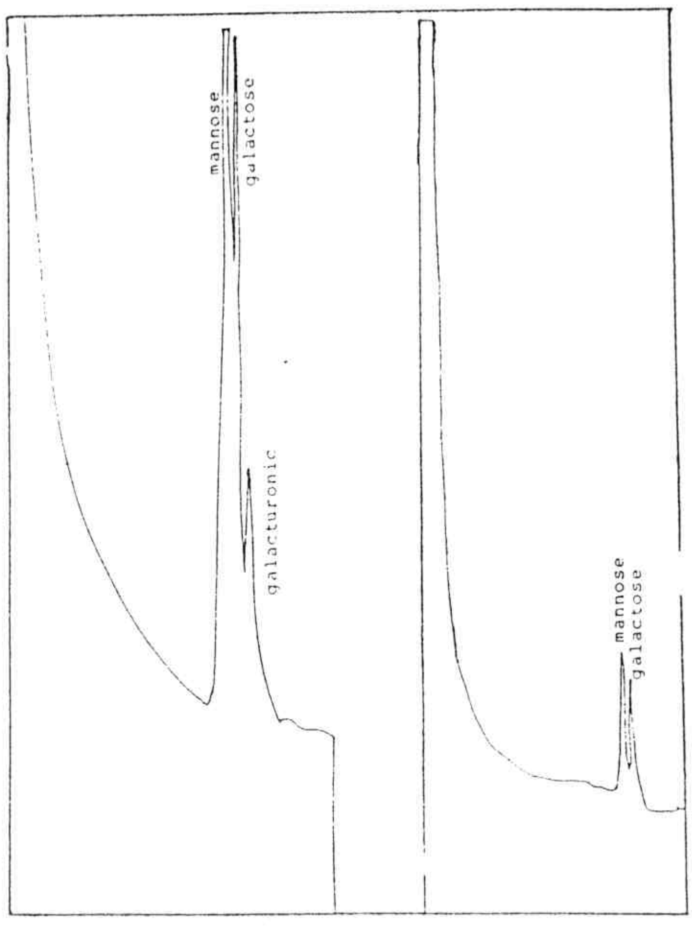

Fig.(10a):

G.L.C. chromatogram of standar simple sugars.

Fig.(10b):

G.L.C. Chromatogram of guar gum hydrolyzate.

3) TECHNOLOGICAL PROPERTIES

One of the important properties of guaran is its ability to hydrate rapidly in cold water to produce highly viscous solutions. Hydration rates and water binding of guar are dependent on the processing techniques used in making the gum and upon the final conditions of the solid material, particularly its particle size. Guar gum when completely hydrated; forms a viscous colloidal thixotropic dispersion (Heyne, and Whistler,1948). As with most other gums, the viscosity of guar is dependent on some factors, i.e. time,temperature, concentration, pH, and type of agitation.

Our study handeled with those factors individually to get aware of the know how of its effect when introduced in food products taking in parellel the other thickening agents. i.e.,C.M.C.,pectin, and arabic gum to be on footsteps in comparison and consideration while performing in food industries.

3-1 THE EFFECT OF TYPE OF AGITATION ON VISCOSITY

In practical application, a hydration time of about 2 hrs is required to reach maximum viscosity. For some application in which there is a need for an immediate high initial viscosity, very fine mesh guar gum can be used;or a technique in agitation has to be practiced.Table (7) showed the effect of electrical stirrir at slow and fast speed (1000-5000 rpm), and also by the magnetic stirrir, on the relative viscosity,while the other factors are fixed. The results showed that, a concentration of (1%) at 25°C of guar and C.M.C. gave a strong relative viscosity (130.9 & 34.1) respectively in slow electric agitation . While pectin and arabic gum gave a low relative viscosity as it was (1.5) & (1.2) respectively at the same speed, i.e.(slow).

On the other hand, it could be seen that slow stirring gave high viscosity while magnetic stirrer gave low viscosity for all solutions. This could be interpreted by the fact that slow speed agitation permit a sufficient time for hydration and allow regularity of dispersion; and narrows the porsity structure of the molecule, while fast speed may affect the time needed and broken the mycellium

Table(7): The effect of type of agitation on viscosity

Type of agitation	t_o solvent flow time/sec.	t flow time in seconds				η_r Relative viscosity			
		guar	C.M.C.	Pectin	Avabic gum	guar	C.M.C.	Pectin	Arabic gum
Electric agitation (slow) 1000 r.p.m	11	1440	375	17	14	130.9	34.1	1.5	1.2
Electric agitation (fast) (5000 r.p.m.)	11	1260	260	15.5	13	110	23.6	1.4	1.1
Magnetic Stirrer	11	1140	198	14	12	103.6	18	1.3	1.0

Note: RElative viscosity of 1% solution at 25°C for 2 hrs.

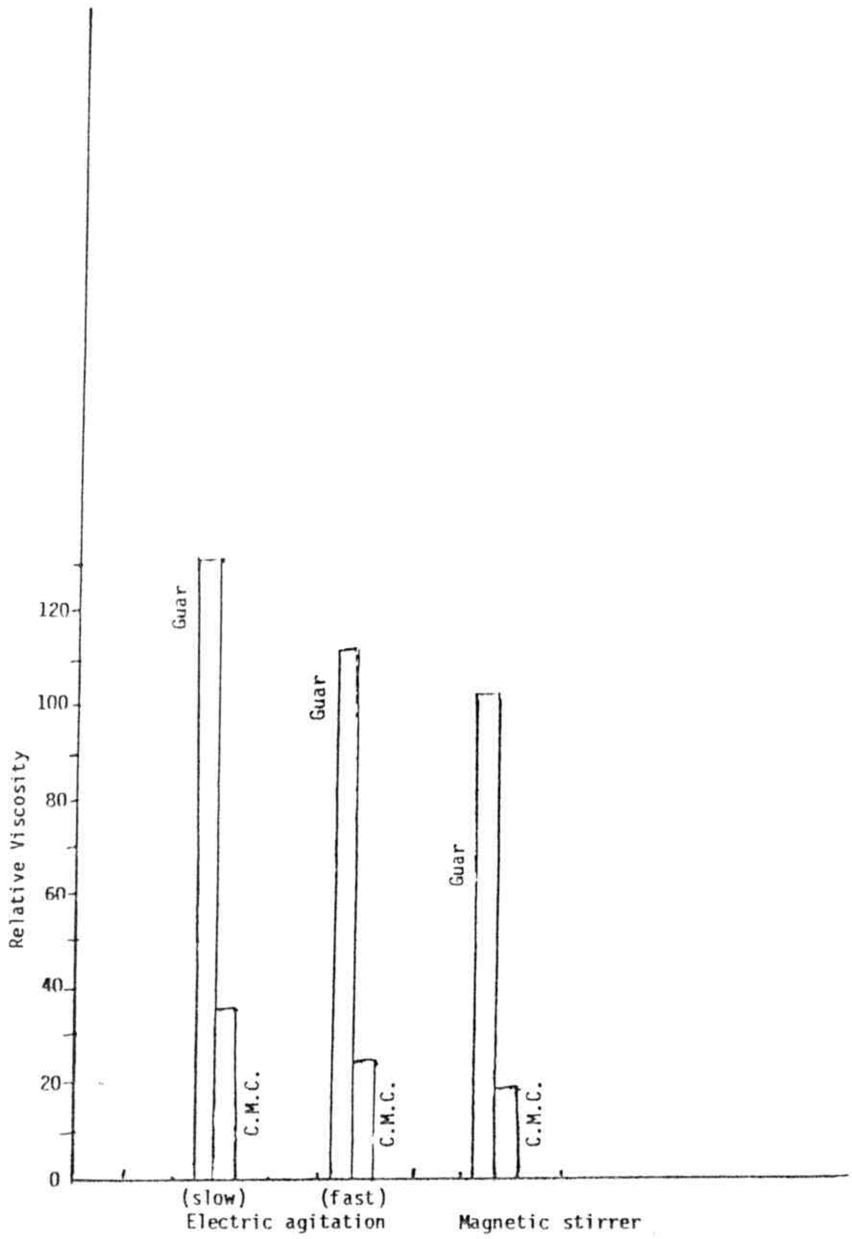

Fig.(14): The effect of type agatation on relative viscosity of guar and C.M.C.

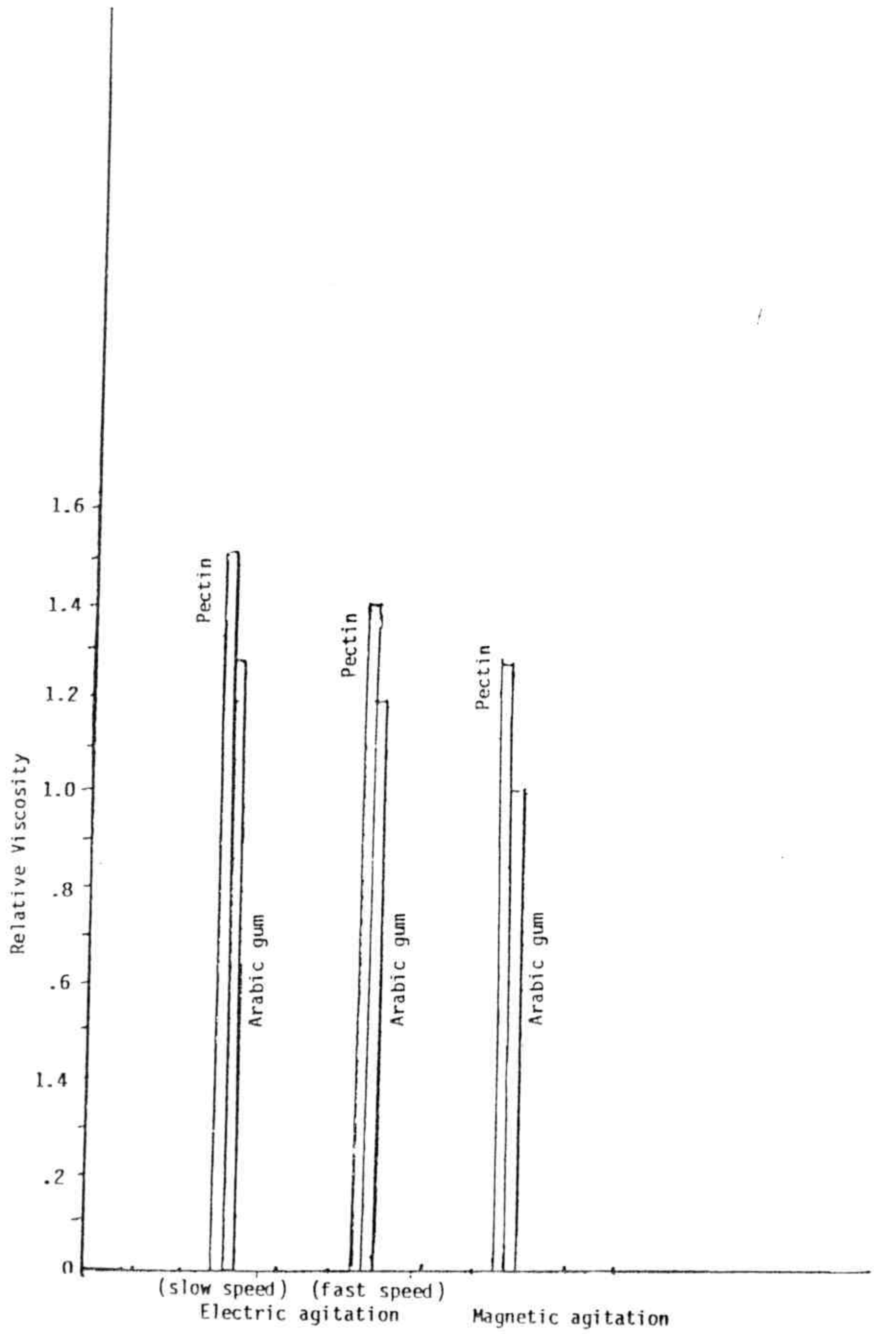

Fig.(15): The effect of type agatation on relative viscosity of Pectin and arabic gum.

system formed and thus introduce irregular dispersion and consequently low viscosity produced 110 & 32.6,1.4 and 1.1 for guar, C.M.C. & Pectin and arabic gum respectively.

It is clear also from this data that slow and fast speed did not affect the viscosity significantly in the pectin,a nd arabic gum. As for magnetic stirrir and its affect on producing low viscosity,(103.6 , 18 , 1.3 and 1.0) in guar and C.M.C. & Pectin and arabic gum, it could attributed to the fact that many polyvalent cations such as calcium, aluminum and chromium insolubilize guar in solutions at certain pH levels. These results were in agreement of Heyne, and Whistler (1948). From these practical results , one can find a way how to deal with guar as a thickening agent in food industry without gessing or problems that may restrict its uses.In this respect Jordan(1961)suggested that, stability of guar solutions or dispersiosn can be improved by including metalic ion sequestering agents, particularly those capable of inactivating iron ions. He offered preferred additives , are citric, tartaric , and orthophosphoric in an amount of 0.25-0.5% based on the weight of guar.

3-2. THE EFFECT OF CONCENTRATION ON VISCOSITY

In dilute solutions, the viscosity of guar gum increses linearly with concentration up to about 1%, thereafter guar gum solutions behave as non-Newtonian solutions mainly as a result of the complex molecular interactions at higher concentration. Results in table (8) showed and assured this phenomena, which were in agreement of those of Ahmed and Whistler (1950). The results also showed that the linearlity in viscosity with increasing the concentration in solution, is not equal in all thickening agents and does not increase parallely to concentration in all cases, Fig.(16,17). Guar gum is the most one to response with increasing concentation. (5.5 , 18.2, 55.9 and 130.9).

This may be attributed to its physical nature and its highly component of galactomannan which have a good physical hydration and dispersion properties. On the other hand, C.M.C.,showed little response to increase viscosity by increasing the concentration (1.8, 4.1, 14.2 and 34.1).

On the other hand, the increase in viscosity by increasing concentrtion in guar can not be accepted epsofacto; but there are some conditions and regulations (such pH, sugar... etc.) which adjusting

Table(8) Effect of concentration on viscosity.

Concentration gm/100 cm^3	t_o solvent flow time seconds	t flow time in seconds				η_r relative viscosity			
		guar	C.M.C.	Pectin	Arabic gum	Guar	C.M.C.	Pectin	Arabic gum
,25	11	60	20	12	11.30	5.5	1.8	1.1	1.03
,5	11	200	45	13	12	18.2	4.1	1.2	1.09
,75	11	615	165	15	13	55.9	14.2	1.4	1.2
1	11	1440	375	17	15	130.9	34.1	1.5	1.4

Relative Visccsity $\eta_r = \frac{\text{flow time in seconds for solution}}{\text{flow time in seconds for the solvent}}$

1% solution at 25°C. (distillation water in presence of potassium permangante)

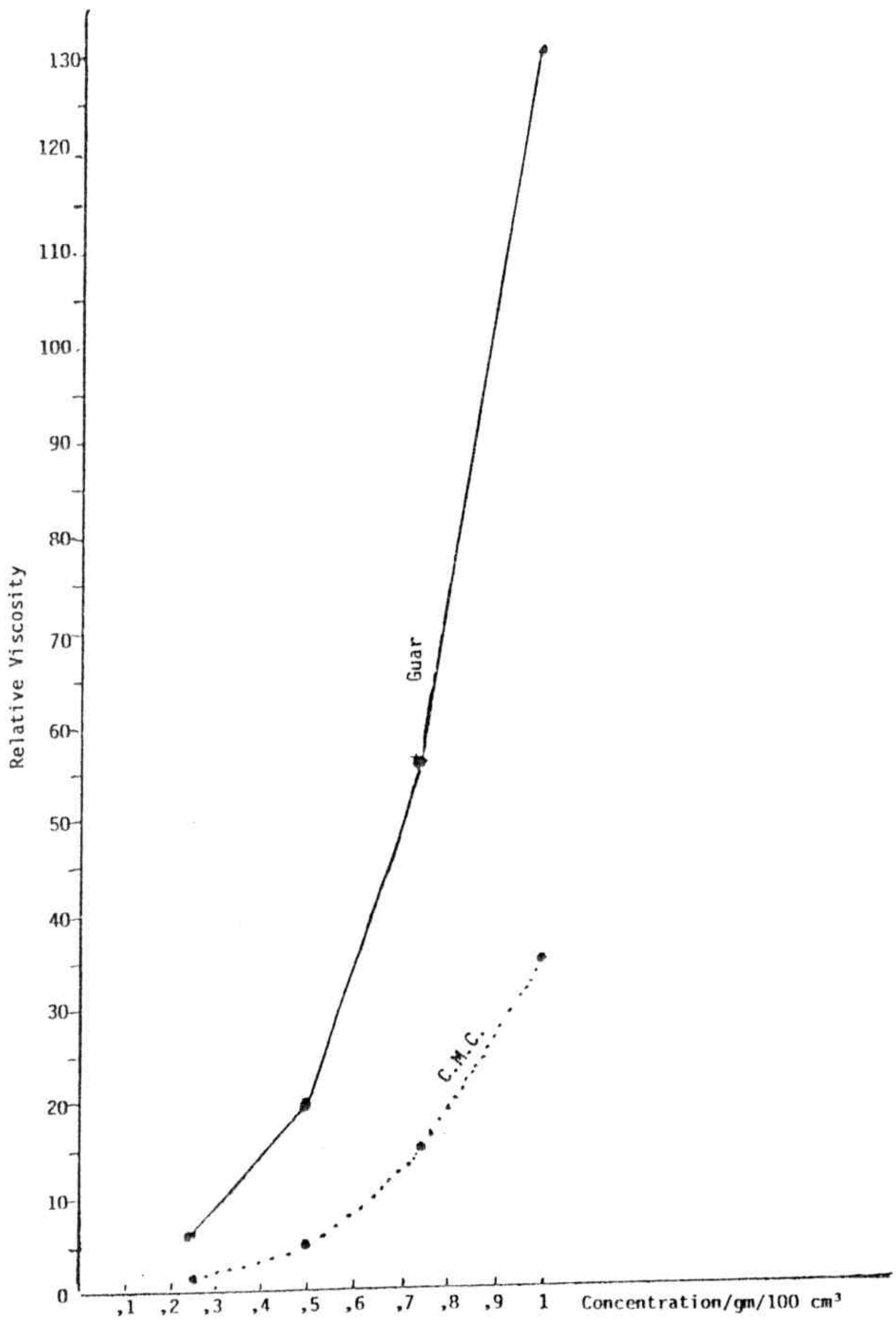

Fig.(16): Effect of concentration on relative viscosity for guard and C.M.C. solution.

the practicing with guar and which must be consider lumpsuly to get the proper concentrtion for the product.

This fact is very important when guar is used in syrups, or juices, and jams.

On the other hand, pectin,and arabic gum did not response significantly by increasing the concentration, the relative viscosity was (1.1 , 1.2 , 1.4 and 1.5) and (1.03 , 1.09, 1.2 and 1.4) in pectin and arabic gum respectively.

These results, confirmed that whatever the increase in concentration of pectin, the most wide use in food products; the increase in viscosity will be restricted and consequently the thickening has to be completed by sugar which form an economic dependent cost on the product.

3.3. THE EFFECT OF pH ON VISCOSITY:

As it is reviewed; guar solution are stable over a pH range of 1.o-10.5, but within cerain preservations, although hydratilon rate is faster over the pH ranges 8-9 and quiet slow below pH 4 (Jordan,1961). Scun phenomena is in agreement with the findings in the carried investigation which are tabulated in table (9) and illustrated in Fig.(18, 19).

As it is shown guar gum of 1% solution showed its higher relative viscosity over a pH range (5,6 and 7) (128.2 , 130.9 and 130.9) and the viscosity inclined to decrease below pH 4 (125.2).

It is also shown that C.M.C. at the same concentration followed the same trend(34 , 32.7 and 31.4). While Pectin showed opposite direction as it gave high relative viscosity at pH 3 (1.6).

This is due to the structure of pectin which consist of polygalactorinic acid; while guar is mainly consist of galactomann.

Generally speaking guar and C.M.C. are in one side, while pectin and arabic gum on the other side. The guar gum and C.M.C. showed higher viscosities as stated before over the pH range (5 ,6 and 7).

Table (9): The effect of pH on viscosity.

pH	Concentration 1 g/100 cm^3	t_o solvent flow time/sec.	t flow time in seconds				η_r relative viscosity			
			Guar	C.M.C.	Pectin	Arabic gum	Guar	C.M.C.	Pectin	Arabic gum
1	1	11	780	75	11.5	11.0	70.9	6.8	1.03	1
2	1	11	840	150	16	11.2	76.4	13.6	1.5	1
3	1	11	1380	270	17	12	125.5	24.6	1.6	1.1
4	1	11	1395	330	16	12.2	126.8	30.0	1.5	1.1
5	1	11	1410	345	14	13	128.2	31.4	1.3	1.2
6	1	11	1440	360	13	13	130.9	32.7	1.2	1.2
7	1	11	1440	375	13	14	130.9	34.0	1.2	1.3

$$\text{Relative viscosity} = \frac{\text{flow time in seconds for solution}}{\text{flow time in seconds for the solvent}}$$

1% solution at 25°C (Distillat water in presence of Potassium permanganate).

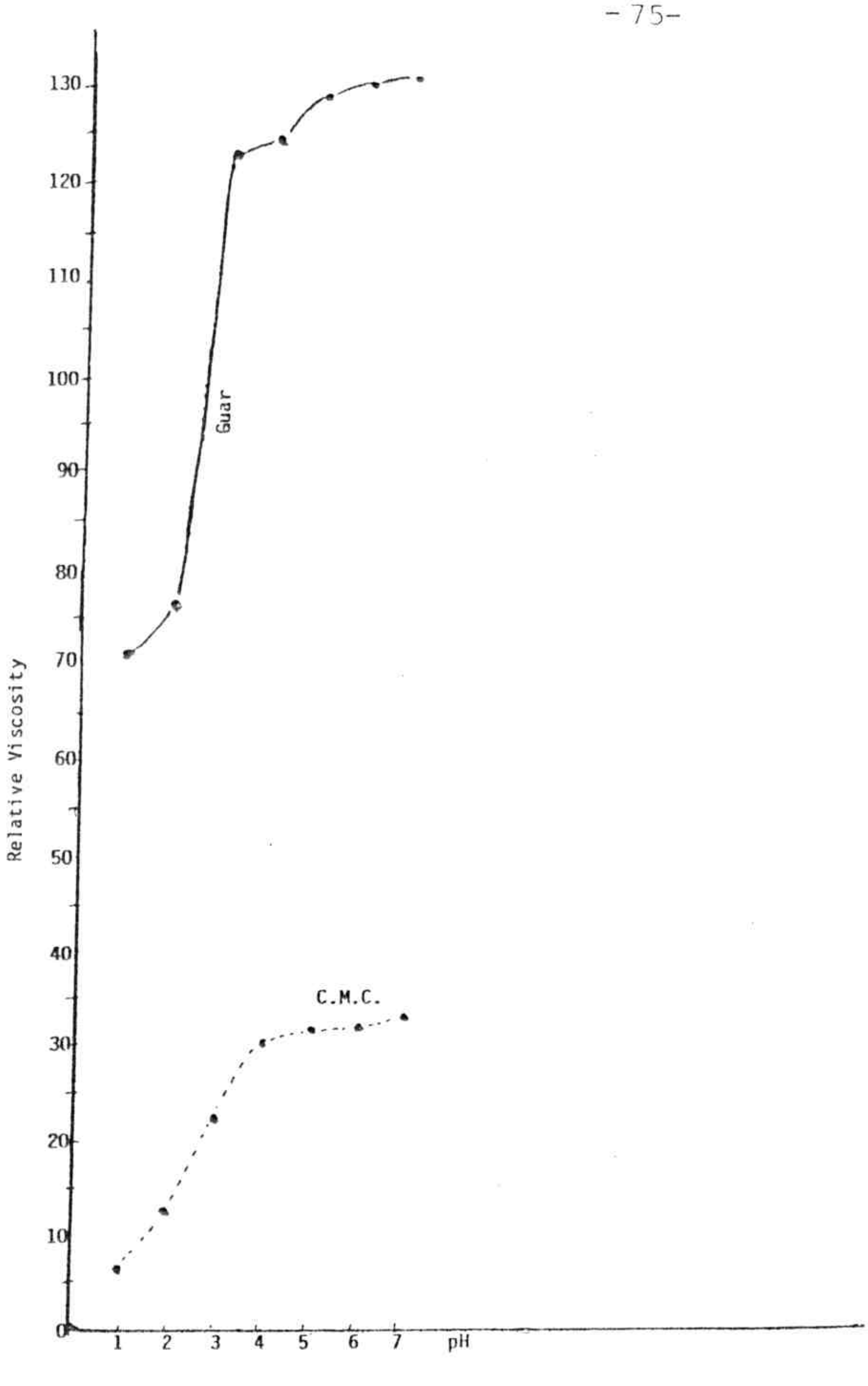

Fig.(18): Effect of pH on relative viscosity of guar and C.M.C. solution.

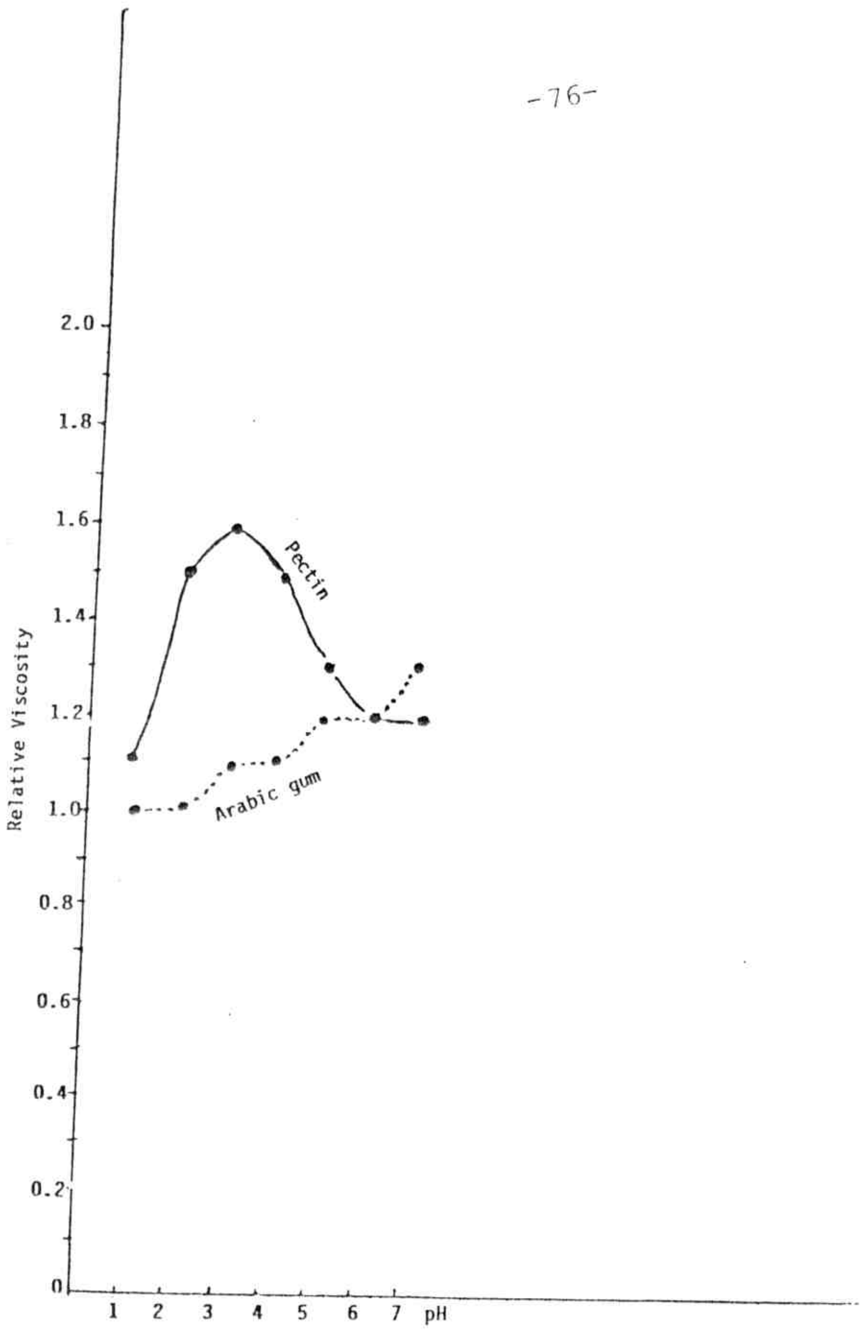

Fig.(19): Effect of pH on relative viscosity of Pectin and arabic gum solution.

From these results we could conclude that the gelling power capacity of pectin need a low pH range to achieve a good relative viscosity; while the use of guar need a pH more higher over a pH 4 to reach a good relative viscosity.

From the economic point of view, one could conclude that in case of fruits having pH over 4, a more citric, or any other buffering agent has to be used, and consequently a more sucrose has to be added to over come the acidic taste and to help in increasing the viscosity. This mean in the end, more costs and the product may be allergic to some people as a result of increasing the acid in the product.

Consequently in such cases, i.e. the uses of fruits having a pH over 4, the use of guar will be more benefit, especially from the economic saving of raw materials, i.e sucrose which will be reflected on the end cost.

Also, guar could be used at a reduced pH below 4,but in such cases it has to be protected from degradation by acid hydrolysis under normal cooking conditions.

Also, and upon these results; guar could be safely used in dairy without creating problems.

3. THE EFFECT OF TEMPERATURE ON VISCOSITY:

Temperature influences the rate of hydration and development of maximum viscosity.Results in Table (10) and Fig.(20 & 21) showed that maximum viscosity was reached at 25°C. in guar and C.M.C. as it was 130.9 & 34.1 respectively. Increasing the temperature of hydration to 40 , 60 and 100°C. Significantly affected the relative viscosity in this two thickening agent i.e. guar and C.M.C as it inclined to decrease by increasing the temperature as it was 120 , 43.6 and 5.5 in guar at 40°C , 60 and 100°C respectively, while it decrease from 31.4 to 21.9 to 5.5 in C.M .C. at the same temperature.

It could be observed from these results that the effect of increasing temperature was more adverse to guar than to C.M.C. as the decrease in guar was more sharp by increasing temperature than in C.M.C.

This may be due to the effect of temperature to be more severe to guar as an organic source, in comparison to C.M.C. which is chemically formulated.

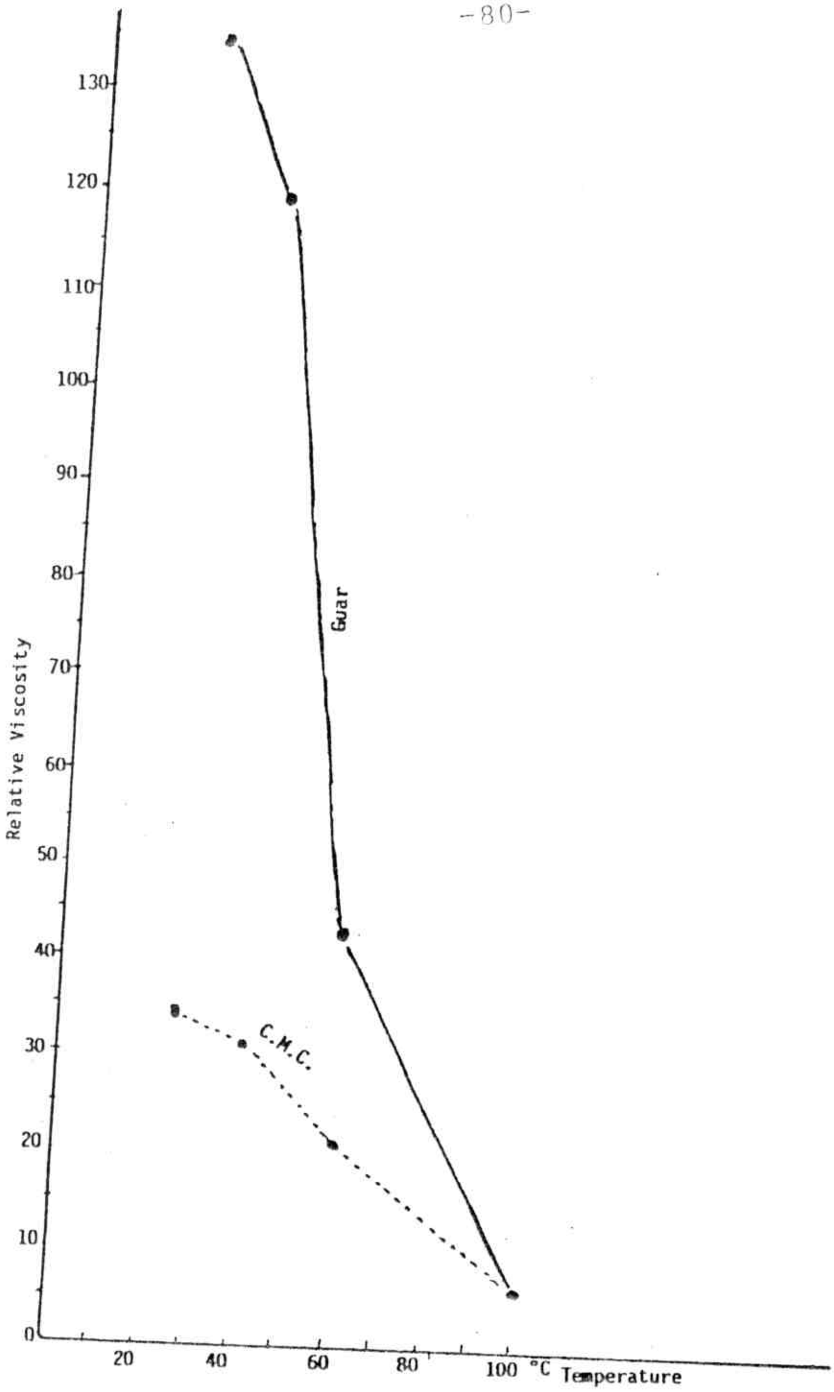

Fig.(20): Effect of temperature on relative viscosity of guar and C.M.C.

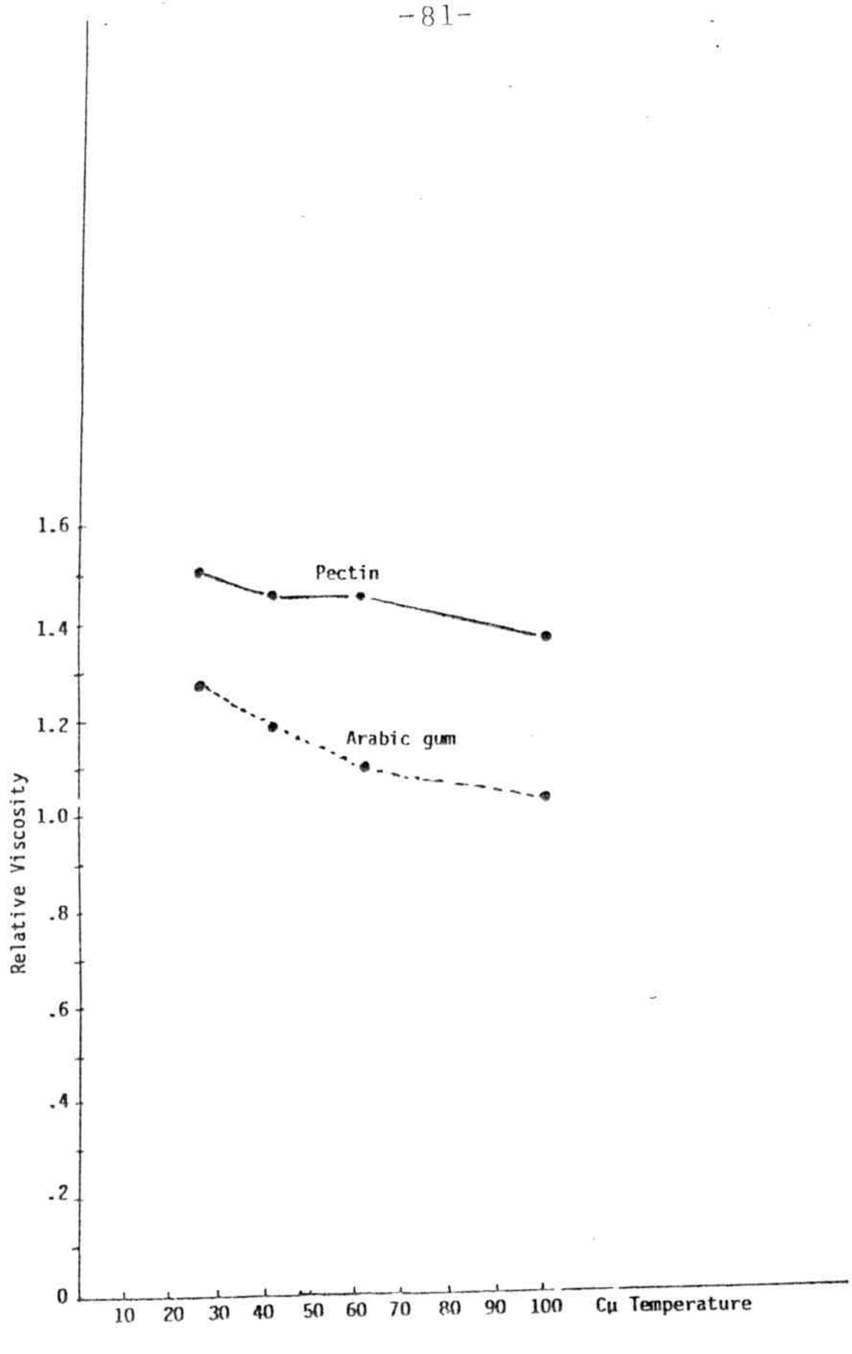

Fig.(21): Effect of temperature on relative viscosity of Pectin and arabic gum.

So for preparing guar solution, cold water is more proportional beside slow hydration to get higher viscosity.

This fact could be useful for preparing natural juices and syrups by cold system.

In case of pectin and arabic gum the increase in temperature did not affect the viscosity; as it was stable along the all degrees. This may be due to its physical and chemical structure which did not response to degradation by heat as happen with guar and C.M.C.

The viscosity in pectin and arabic gum was (1.5, 1.5 , 1.5 and 1.4) and (1.3 , 1.2,1.1 and 1.0) respectively at 25,40, 60 and 100°C.These results were in agreement with those of Jordan (1961).

So, it could be concluded that maximum viscosity of guar gum dispersion is achieved with temeprture of 25-40°C.

3-5 EFFECT OF ADDITION OF SUCROSE ON VISCOSITY

Results in Tables(11) and Fig . (22) showed that the addition of sucrose significantly affected the relative viscosity in the solution.

The addition of sucrose to guar solution decreased the viscosity by increasing the sucrose addition; the viscosity was 99.8 by adding 3 gm of sucrose to the 1% solution of guar gum and decreased to 87.3 and to 79.1 and 70.9 and 59.5 at addition of 5 , 10, 15 and 20 gm sucrose respectively.

On the other hand, it was shown from the same table that the concentration of sucrose increase the viscosity with the other thickening agents by increasing the concentration of sucrose.

This was clearly found in C.M.C. solution as the viscosity increased from 34.1 at 3 gm sucrose to 44.5 at 20 gm sucrose.Also, pectin, and arabic gum followed the same trend, as the viscosity increased linearly with increasing sucrose, but the increase in viscosity in this two agents were not at the same level as in C.M.C. which significantly response with the increament of sucrose. These findings were in agreement of Carlson, and Ziegenfurs (1965) who reported that guaran, in the presence of sugar will compete for the available water, and that high percentage of sugar have a marked delaying action on the hydration of the gum, consequently the viscosity of guaran sugar solutions will decrease gradually in direct proportion to the sugar concentration. This interpretetion coincide perfectly with the results obtained in concern to guar gum.On the other hand; the stored guaran solution, will develop full viscosity after ten days as it is clear from table (12) and Fig.(22,23). The viscosity increased from 99.8 at a concentration of 3 gm. to 158.2 after ten days storage. The increamen was followed in the other concentration upon storage, and also in the other agents.

This will lead to an indication that all the thickening agents increase its viscosity on prolonged storage.

This phenomena has to be consider during processing foods, especially jams and juices or it will adversely affect the apparant appearance and consequently the sales appeal. So far, it could be advised that the presence of sugar of 5-10% and not more will improve the viscosity of the product especially on prolonged storage. Sugars also offers protection from acid hydrolysis down to pH_3 under normal cooking conditions.

Table(11): Effect of addition of sucrose on viscosity (Instantly).

Addition of sucrose to 1% solution	t_o solvent flow time seconds	t flow time in seconds				η_r relative viscosity			
		Guar	C.M.C	Pectin	Arabic gum	Guar	C.M.C.	Pectin	Arabic gum
3 gm sucrose	11	1098	375	1.2	1.2	99.8	34.1	1.1	1.1
5 gm sucrose	11	960	390	1.3	1.3	87.3	35.5	1.2	1.2
10 gm sucrose	11	870	440	1.5	1.4	79.1	40.0	1.4	1.3
15 gm sucrose	11	780	470	1.6	1.5	70.9	42.7	1.5	1.4
20 gum sucrose	11	600	490	1.8	1.6	59.5	44.5	1.6	1.5

$$\text{Relative viscosity} = \frac{\text{flow time in seconds for solution}}{\text{flow time in seconds for the solvent.}}$$

Table (12): Effect of addition sucrose on viscosity (after 10 days storage).

Addition of sucrose to 1% solution of gums	t_o solvent flow time in seconds	t flow time in seconds				η_r Relative viscosity			
		Guar	C.M.C.	Pectin	Arabic gum	Guar	C.M.C.	Pectin	Arabic gum
3 gm sucrose + 1%	11	1740	390	13	13	158.2	35.5	1.2	1.2
5 gm sucrose + 1%	11	1680	420	14	14	152.7	38.2	1.2	1.3
10 gm sucrose + 1%	11	1620	465	16	15	147.3	42.3	1.5	1.4
15 gm sucrose + 1%	11	1560	485	17	16	141.8	44.1	1.55	1.50
20 gm sucrose + 1%	11	1500	510	19	17	135.4	46.4	1.7	1.55

$$\text{Relative viscosity} = \frac{\text{flow time in seconds for solution}}{\text{flow time in seconds for the solvent}}$$

(Distillat water in presence of potassium permanganate)

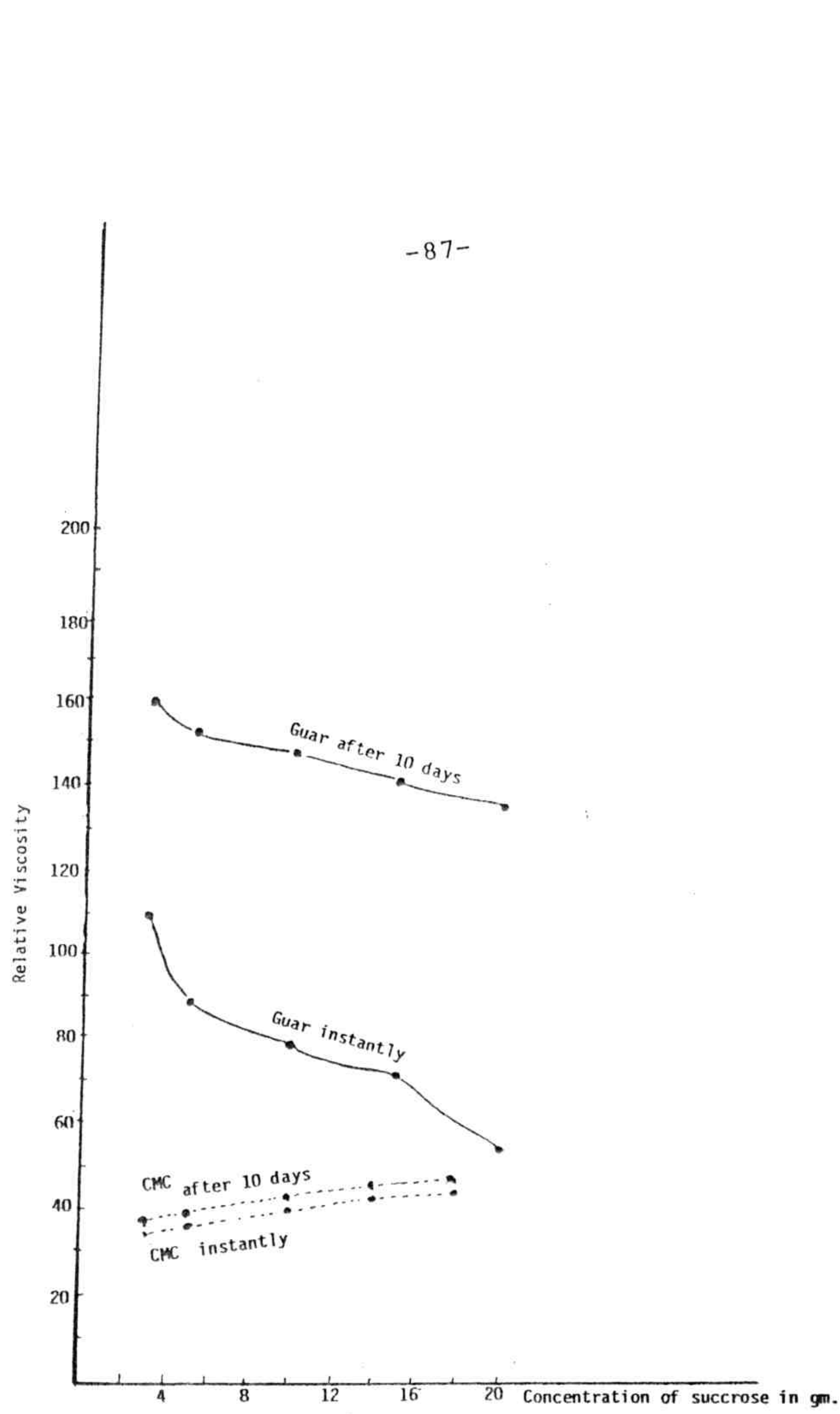

Fig.(22): Effect of addition sucrose on relative viscosity of guar and C.M.C. solutions.

4) INDUSTRIAL APPLICATION

4-1 In Jams:

The importance of thickening agents especially those from organic sources occupied the interest of food technologists especially in the field of fruit manufacturing. The use of guar as organic thickening source draw attention of the world since no long time.

In Egypt the problem of thickening agents rise to the surface after the inflation wave prevails all over the world. Canners are more impacted and suffering from this wave; and the head sky prices which reflect its impactness on the sales amount, and consequently threatened the fruit manufacturing and all related fields. so, come, the idea of using guar gum as pectin substitute to overcome this problem. Also by getting acquianted of this material, we try to solve the problem of sucrose which also commence to form a gohst to this industry.

Many efforts were exploited to substitute sucrose by high liquid fructose which is high sweetened 1.5 time of sucrose and which is not harmful to diabetes.

The problem of substituting sucrose by fructose embedded in the low density and liquidity of fructose which did not form the required thickening and concentration point in the end product.

So, the core of this work is embedded in how to reach a good thickening and stabilization and substitute even partially a portion of sucrose content. The results in Tables (13-20) showed that good results were obtained along strawberry and apricot jam The concentration of guar gum showed to play important role in thickening the jam and introduce the same function of pectin. The viscosity in both two jams were found to increase linerally by increasing the guar concentration from 0.5 to 0.7 to 1 g. kg. of the sugar.

As it is clear from the data, there was a substantial difference in viscosity in the different sugar treatments.

The results showed that guar compete in presence of sugar for the available water, and the presence of sugar delayed the hydration of the guar, so, the viscosity decrease gradually in direct proportion to the sugar concentration. The average decreament in apricct jam fall from 43660 cps to 30186 and from 34700 to 18400 cps and from 2900 to

17440 cps and from 18900 to 13280 cps in the treatments 1,2,3 and 4, respectively.

The same trend was observed in strawberry jam, the average decreament in viscosity fall from 27839 to 18773 in 100% sucrose and 21515 to 15840 in 60% sucrose and 14630 to 7893 in 40% sucrose and 11662 to 7200 in 100% fructose treatments respectively. The results also showed that the sugar proportion, i.e., sucrose /fructose ratio impact and interfere in the bodying structure of the jam depending upon the percent of each sugar to the other. The increase in fructose to sucrose lead to a decrease in the viscosity of both jams and vice versa. The decrease in apricot jam was from 30186 cps in 100% (S.) to 18400 cps in 60%(S) and 40% (F. and to 17440 cps in 40% S plus 60% F. and to 13280 cps in 100%(F.). Also the decreamen in strawberry jam was from 18773 cps in 100%(S) to 15840 cps in 60%(S.) plus 40% (F.) and to 7893 cps in 40% (S.) plus 60% (F.) and to 7200 cps in 100% (F.). On the other hand, it was shown that the decreament in viscosity could be reimbursed by increasing the guar concentration in the jam. Results in table (29) showed that the average viscosity increased linerally on increasing the guar concentration in all treatment and in both two jams. The increament percentage Table (30) showed to be tied to the kind of treatment; in other words the role of sucrose /fructose ratio play an important role in the this respect, beside the guar concentation. Generally speaking, the increament was tied with the variety of the fruit processed. The response was pronounced in apricot than in straw berry, which may be attributed to its high structure content of soluble solid and pectin substances, which syngergestically act with guar concentration especially with what known about appricot to be rich in calcium and other minerals such elements self protect guar concentation and help in increasing the viscosity especially in case of using 60%(S.) and 40% (F.) and 40%(S.) and 60% (F).

The speed rotation rate over scale of 10,20 and 50, could affect the treatments in both two jams. The viscosity reached the maximum peak at speed 10; and decrease upon exceeding the speed to 50.

This decrease may be due to the mechanical effect which break the consistency of the gel structure upon increasing the speed, or may be to the short period allowed to get good dispersion and to build up the gel structure. Due to this effect, one can conclude that the revolution speed of agitator should not exceed than to during manufcturing of jams.

The gel strength as a factor of quality attribute was also considered in this work. As it is shown in table(13-20) the gel strength was proportionally increased by increasing the guar concentration; but the increament differ according to the type of sugar treatment and the variety of the processed fruit. It reached its maximum in 100%(S.) with 1.0 g./kg in apricot jam; although some what less in strawberry jam. Coming in sequence, the 60% (S) followed by the other two treatments. Strawberry jam as stated was less strength than appricot in the same treatment.

As for quality attribute, sensory evaluation by 7 person scored for color, taste,flavor, and texture of the two jams. As it is shwon from tables (21-28) the sucrose/ fructose ratio affected the sensory evluation in each jam especially from color point of view. This effect was more pronounced in apricot jam than in strawberry, which may be due to the natural Pigments in each fruit and its response with fructose sugar. Evidence to this inference, the apricot jam scored the highest rate with 100% fructose, followed by 60% fructose, and 40% fructose, whilest this effect was not so equivalent in strawberry as in apricot jam,although the 100% , 60% fructose scored higher than the other treatments.

From these results we could conclude that, the substitution of sucrose by 60% or 100% fructose could get good results with guar concentration ranged over 0.7 - 1.0 g/ kg of sugar, which will reflect on the sales amount, taking in consideration that jams with high fructose is more healthy for diabeted and also for others. By this way, the problem which restrict the use of higher fructose was over come by substituting guar gum instead of pectin substances which become very expensive and need special condition of pH and sugar concentration, to get the need concentrated point.

Table(13) Effect of 100% sucrose(s) on viscosity of apricot jam at different concentration of guar.

Treatment	Viscosity /spindles 5 speed				gel strength
	10	20	50	average	
1) Apricot + 100% s. (control	66000	38900	21700	43660	++
2) " + 100&(S.)+ 0.5 g/kg	38400	25600	15360	30186	+++++
3) " + " + 0.7 g/kg	59200	35200	23200	39146	++++++
4) " + " + 1.0 g/kg	102400	56000	26560	61653	+++++++

Table (14): Effect of 60% sucrose(s) and 40% fructose(f) on viscosity of apricot jam at different concentration of guar.

Treatment	Viscosity/spindle 5 speed				Gel strength
	10	20	50	average	
1) Apricot + 60%(S.)& 40%(F)control	51400	35200	17300	34700	++
2) " + " (S.)& " (F) + 0.5 g/kg	28000	16000	11200	18400	++++
3) " + " (S.) & 40% F) + 0.7 g/kg	40000	30400	14750	28383	+++++
4) " + " (S.) & 40%(F) + 1.0 g/kg	86400	5920C	26200	57466	++++++

Table(15) Effect of 40% sucrose(S) & 60% fructose (F) on viscosity of apricot jam at different concentration of guar.

Treatment	Viscosity /spindle 5 speed				Gel strength
	10	20	50	Average	
1) Apricot + 40% S. & 60% F.(control)	42600	29800	14480	29000	++
2) " + 40% S.& 60% F.+ 0.5 g/kg	25600	18400	8300	17440	++++
3) " + 40% S.& 60% F.+ 0.7 g/kg	38400	27200	13440	26340	+++
4) " + 40% S. & 60 F.+ 1.0 g/kg	64000	44000	21000	43133	++++

Table(16): Effect of 100% Fructose(F.) on viscosity of apricot jam at different concentration of guar.

Treatment	Viscosity/spindle 5 speed				Gel strength
	10	20	50	Average	
1) Apricot + 100% F (Control)	28000	18000	10700	18900	++
2) Apricot + 100% F. + 0.5 g/kg	19200	13600	7040	13280	+++
3) Apricot + 100% F. + 0.7 g/kg	28000	16000	11200	18400	+++
4) Apricot + 100% F. + 1.0 g/kg	36800	24800	14080	25226	+++

Table(17): Effect of 100% sucrose (S.) on viscosity of strawberry jams at different concentration of guar.

Treatment	Viscosity/spindle 5 speed				Gel strength
	10	20	50	Average	
1) Strawberry + 100%(S.) without guar (control)	39000	29333	14720	27839	++
2) Strawberry + 100% sucrose + 0.5 g / kg	28800	19200	10320	18773	++++
3) Strawberry + 100% sucrose + 0.7 g /kg	32000	30400	16640	26346	+++++
4) Strawberry + 100% sucrose + 1.0 g /kg	57000	38400	19200	38400	++++++

Table (19): Effect of 40% Sucrose(S.) & 60% Fructose(F.) on viscosity of strawberry jam at different concentration of guar.

Treatment	Viscosity/spindle 5 speed				gel strength
	10	20	50	Average	
1) Strawberry + 40% (S) & 60% F.(control)	21600	15200	9813	14630	++
2) " + 40% S & 60% F.+0.5 g/kg	11200	8200	4480	3893	++
3) " + 40% S & 60% F.+0.7 g/kg	25600	18400	7640	17226	+++
4) " +40% S. & 60%F.+ 1.0 g/kg	28000	19200	8320	18773	++++

Table(20): Effect of 100% Fructose(F) on viscosity of strawberry jam at different concentration of guar.

Treatment	Viscosity/spindle 5 speed 10	20	50	Average	Gel strength
1) Strawberry + 100% F. (control)	16000	11800	8146	11662	+
2) " " +100% F. + 0.5 g/kg	8000	7400	6200	7200	+
3) " " + 100% F.+ 0.7 g/kg	17600	11200	7040	11946	++
4) " " +100 % F.+ 1.0 g/kg	22400	16800	11200	15840	+++

Table(21): Quality attribute of 100%(S.) on apricot jam at different concentration of guar.

Treatment	Quality attributes score.				
	Taste	Color	Flavor	Texture	Average
1) Apricot + 100%(S.) control	7	6.6	6.0	6.3	6.4
2) Apricot + 100%(S.) + 0.5 g/kg	7.5	6.3	6.1	6.6	6.6
3) Apricot + 100%(S) + 0.7 g/kg	6.3	6.6	6.0	6.0	6.2
4) Apricot + 100%(S.) + 1.0 g/kg	7.3	7.0	6.0	6.3	6.7
Total					25.9

Table(22): Quality attribute of 60% (S.) + 40% (F.) on apricot jam at different concentration of guar.

Treatment	Quality attribute score				
	Taste	Color	Flavor	Texture	Average
1) Apricot + 60%(S.)/40%(F.) control	7.5	7.9	7.3	7.8	7.5
2) " + 60%(S.)/40%(F.)+0.5 g/kg	8.0	8.5	7.3	8.0	7.9
3) " + 60%(S.)/40%(F.) + 0.79 g/kg	8.5	8.5	6.0	8.5	7.8
4) " + 60%(S.)/40%(F.)+1.09 g/kg	7.3	6.8	8.6	6.5	7.2
Total					29.4

Table(23): Quality attribute of 40% (S.)/60% (F.) on apricot jam at different concentration of guar.

Treatment	Quality attribute score				
	Taste	Color	Flavor	Texture	Average
1) Apricot + 40%(S.)/60% (F.) control	7.6	7.3	7.0	7.0	7.02
2) " + 40%(S.)/60%(F.)+0.5g.g/kg	7.6	7.3	7.0	7.3	7.0
3) " + 40%(S.)/60%(F.)+ 0.7 g/kg	7.6	7.0	7.0	6.8	6.8
4) " + 40%(S.)/60%(F.)+1.0 g /kg	8.0	9.3	7.3	8.3	8.2
Total					29.2

Table(24): Quality attribute of 100%(F.) on apricot jam at different concentration og guar.

Treatment	Quality attribute score				
	Taste	Color	Flavor	Texture	Average
1) Apricot +100% (F.) control	8	9	7	8	8
2) " +100% + 0.5 g.g/ kg	8	9.3	7.6	7.3	8
3) " +100% " + 0.7g.g/kg	8	9.3	7.3	8.0	8.2
4) " +100% " + 1.0g.g/kg	8	9.3	7.3	8.3	8.2
Total					32.4

Table(25): Quality attribute of 100%(S.) on strawberry jam at different concentration of guar.

Treatment	Quality attribute score				
	Taste	Color	Flavor	Texture	Average
1) Strawberry+ 100%(S.) control	7.5	7.3	7.5	7.7	7.2
2) " " (S.)+ 0.5 g.g/kg	7.0	7.0	6.3	7.4	6.9
3) " " (S.)+ 0.7 g.g/kg	7.4	7.0	7.4	7.2	7.3
4) " " (S.)+ 1.0 g.g/kg	7.5	7.4	7.2	7.4	7.3
Total					28.7

Table(26) Quality attribute of 60%(S.) and 40% (F.) on strawberry jam at different concentration of guar.

Treatment	Quality attribute				
	Taste	Color	Flavour	Texture	Average
1) Strawberry + 60% (S.) & 40%(F.(control)	7.1	6.9	6.5	7.2	6.9
2) " + " " & " + 0.5g.g/kg	7.0	7.0	6.3	7.4	6.9
3) " + " " & " +0.7g.g/kg	7.2	6.6	6.4	7.4	6.9
4) " + " " & " +1.0g.g/kg	7.3	7.2	6.9	6.8	7.0
Total					27.7

Table(27): Quality attribute of 40%(S.) /60% (F.) on strawberry jam at different concentration of guar.

Treatment	Quality attribute score				
	Taste	Color	Flavor	Texture	Average
1) Strawberry + 40% (S.)/60%(F.)control	7.4	7.3	6.9	7.7	7.3
2) " " " " + 0.5 g.g/kg	7.2	6.6	7.0	8.2	7.3
3) " " " " + 0.7 g,g/kg	7.8	6.8	6.8	7.1	7.1
4) " " " " + 1.0 g.g/kg	7.3	7.5	7.1	8.0	7.7
Total					29.4

Table(28): Quality attribute of 100% (F.) of strawberry jam at different concentration of guar.

Treatment	Quality attribute score				
	Taste	Color	Flavor	Texture	Average
1) Strawberry + 100 % (F.) (Control)	7.1	6.9	7.0	7.6	7.1
2) " " + g.g./ 0.5 g.g. / kg	7.4	6.6	7.0	8.2	7.3
3) " " + g.g./ 0.7 g.g./ kg	7.1	7.5	7.3	7.4	7.3
4) " " + g.g. + 1.0 g.g / kg	7.1	7.5	7.3	7.4	7.3
Total					29.0

Table(29): Average viscosity in strawberry and apricot jam as affected by different treatment.

Sugar treatment	Guar concentrationg./kg					
	Strawberry			Apricot		
	0.5	0.7	1.0	0.5	0.7	1.0
1) 100% (S.)	18773	26346	38400	30186	39146	61653
2) 60% (S.) + 40% (F.)	15840	21700	27000	18400	28383	57466
3) 40% (S.) + 60% (F.)	7893	17226	18773	17440	26340	43133
4) 100% (F.)	7200	11946	15840	13280	18400	25226

Table(30): Percentage increament of viscosity as affected by different treatment

Sugar treatment	Strawbarry jam		apricot jam	
	Guar concen. g/kg		Guar concen. g/kg	
	0.7	1.0	0.7	1.0
1) 100% sucrose(S.)	40.3	104	29	104
2) 60%(S.) + 40% (F.)	37	71	54	212
3) 40% (S.) + 60%(F.)	117	137	51	147
4) 100% Fructose (F.)	64	120	38	89

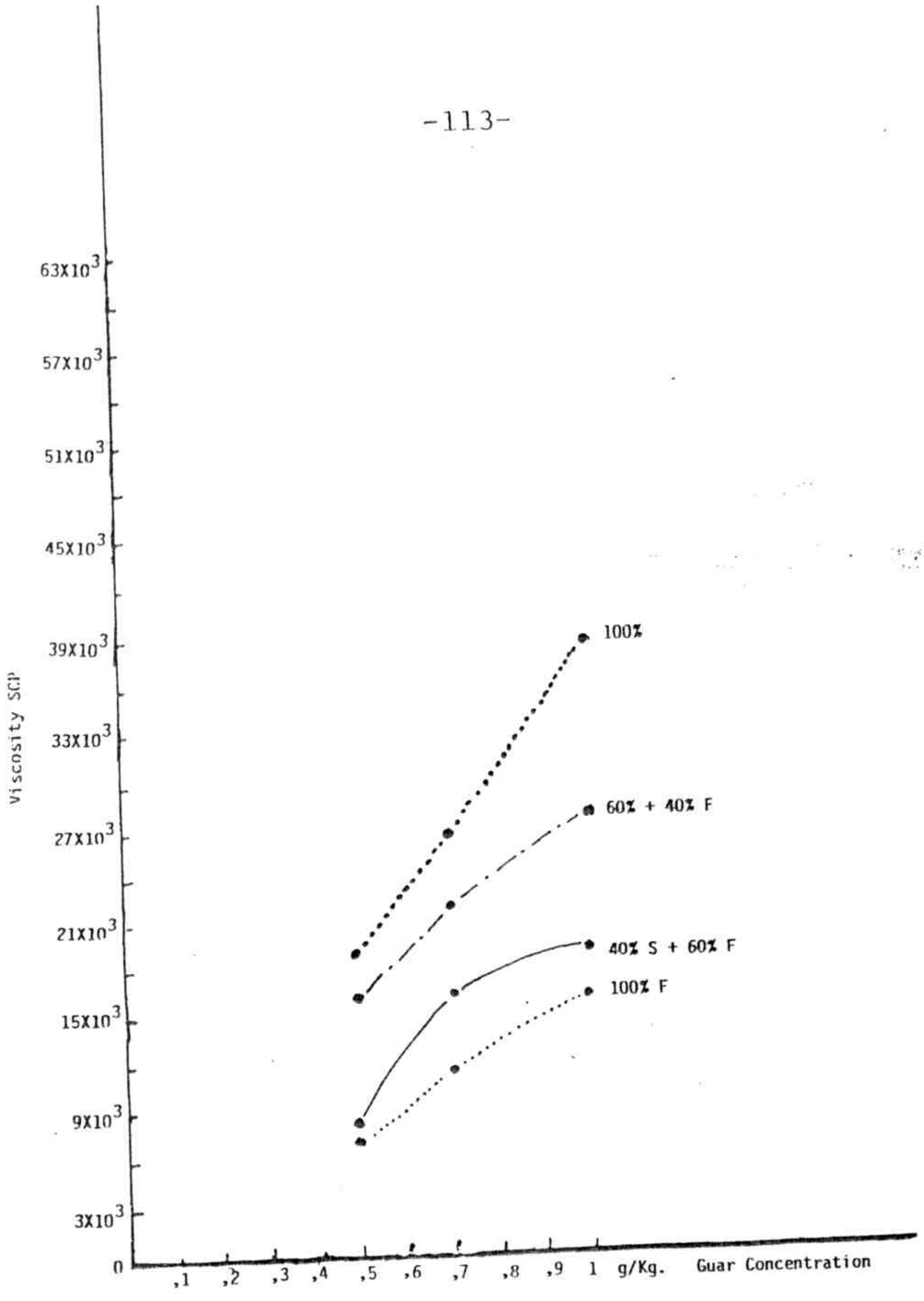

Fig.(24): Average viscosity in Strawberry jam as affected by guar concentration.

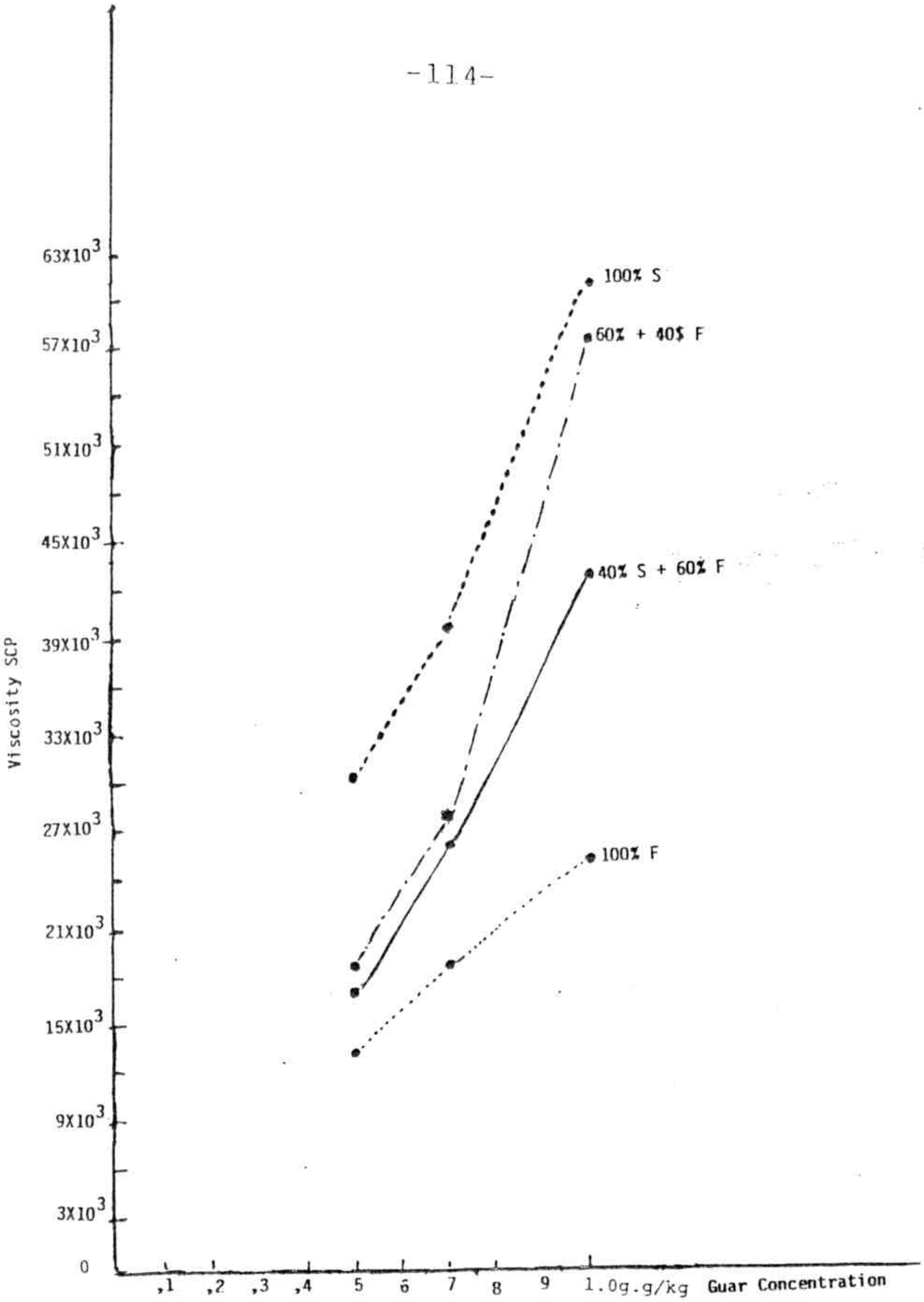

Fig.(25): Average viscosity in apricot jam as affected by guar concentration.

4-2 IN Juices

4.2.1 Orange Juice:

The natural juices are always subjecting to separating as the colloidal substances tend to precipitate leaving transparent serum which affect the acceptability of the consumer. This phenomena which appears after processing and short storage, could be treated by addition of thickening agents.

The effect of guar and the other thickening agents on the stability of orange and tomato juices and also on concentrated orange juice were studied. Results in tables (31-34) showed the effect of different concentration of guar & C.M.C. & Pectin and arabic gum, on the cloud stability of pasteurized and non pasteurized orange juice. As it is shown from the results obtained, pasteurizing the juices had a great effect on the cloud stability of the juice; as a result of the effect of heating on the accumulation of the colloidal substance in the juice and subsequently on its effect on the cloud stability of the juice.

As it is clear from table (31) the concentration of guar had a significant cloud retention which was proportionally linered with the guar concentration.

Juice transmission at 1% guar concentration was less than at concentration of 0.7% and subsequently at 0.5%.The transmission percent at these concentrations were (16.8, 19.9, 37) in the pasteurized orange juices; while they are (12.2, 16.7 and 30.2) in the non pasteurized juices which showed that pasteurizing affect the colloidal system in the juice.

On the other hand, the storage period also affect the cloud stability during storage in both pasteurized and non pasteurized juice; although it was accelerated in pasteurized than non pasteurized juice at the same concentration of guar.

As for the effect of carboxymethyl cellulose (C.M.C) on the cloud stability of the single orange juice, it is shown from table (32) that the concentration used; play an important role in maintaining the cloud stability which was proportionally with the concentration used. As stated in guar; the storage period also affect the cloud retention; as the transmission percent increased by storage, although it was somewhat higher with C.M.C., than with guar at the same concentration which mean that guar maintain the juice more stable than C.M.C.

The effect of pectin on the cloud stability was recorded in table (33). As it is clear from the results obtained, Pectin was less effective in maintaining the stability in comparison to guar or C.M.C.

The concentration of pectin also showed to maintain some retention of stability. The transmission percent of the juice was proportionally opposite while increasing the pectin concentration. The state of juice, pasteurizing or non pasteurizing showed to effect the stability during the course of storage. Pasteurizing; as stated before help to floc the colloidal substance and consequently increasing the transmission percent. In this capacity the addition of any thickening agent with high concentration (0.5–1%) will help in reducing the transmission rate, i.e. Increasing the cloud stability of the juice.

On the other hand, arabic gum (table 34) showed to be the least thickening agent in maintaining stability; although it showed good response with high concentration i.e. (1%) followed by the (0.75) concentration; and the least concentration effect was (0.5%). The storage period also effect the stability state, as the transmission rate increased up to storage period.

From the mentioned results in table (31-34) it could be concluded that guar as a thickening agent was found to be prosper in maintaining the cloud stability of orange juice especially at 1% concentration, and is consider superior from organic ponit of view to C.M.C. which also give a good response in stabilizing the juice; although we cannot advise due to its chemical synthetic structure.

Pectin and arabic gum can also fulfill the requirement needed to stabilize the juice, but at high concentration (1%).

As for concentrated orange juice guar gum of concentration 1.5, 1, 0.7, 0.5 were added to concentrated juice of 45% T.S.S. The transmission percent of reconstituted juice in ratio (9 : 4) was recorded in table (35). It is shown from the results obtained that; the stability of the juice was increased linerally by increasing the guar concentration giving maximum response at 1.5%. Any how; the stability of the concentrated juice was more pronounced and more response to stabilization at any concentration rate in comparison to single strength juice. This phenomena indicate; that guar is highly effective with high soluble solids and form a jel structure which maintain the juice cloudy, shows and prevent separation of serum along the storage course. So, one can advice the addition of guar at a ratio of 1.5% without frighten of achieving a plastic state which affect the showing appeal of the juice.

The change in juice transmission was slightly followed by chemical and physical changes along the storage period (table 36-40). Results showed that as transmission increased, the viscosity tend to decrease in all cases, although the jel strength did not affect significantly especially in the high concentration of the thickening agents. Along these changes; the chemical properties also shows to affect although they were not significant. The different concentration of the thickening agent; did not show a significant affect on the chemical properties except in case of guar on the pH value; as the pH increase slightly in comparison to control. Also the increase in concentration of guar intend to increase with pH. This fact must be consider to adjust the composition within the limits of the normal standards.

On the other hand, the jel strength showed to be related to the agent used; the highest was with guar gum, followed by C.M.C. pectin and the lower was with arabic gum.

The concentration ratio of the thickening agent was less effective in the respect. This may be due to the effect of other constituents which may interfere in the jelling power capacity.

From these results it could be concluded that guar gum in concentration of 1% is suitable for maintaining the cloud stability of both single and concentrated orange juice.

** **

Table (31): The effect of guar on the cloud stability of single strength orange juice.

Treatments	Transmission %					
	Pre-storage	Storage period/day on 25°C				
	0	15	30	45	60	75
Pasteurized orange juice control	20.7	24.9	35.5	47.8	58	69
Pasteurized orange juice + 1% guar	2.1	6.2	8.5	10.8	12.3	16.8
" " " + ,7% guar	3.1	7.4	9.1	14.4	16.3	19.9
" " " + ,5% guar	5.1	12.6	17.7	22.6	28.9	37
Non-Pasteurized orange juice control	15.5	23.3	29.8	39.9	45.6	5.5
" " " + 1% guar	1.1	4.2	6.1	7.4	9.2	12.2
" " " + ,7% guar	2.1	8.2	7.5	9.9	13.5	16.7
" " " + ,5% guar	4.4	10.7	15.3	19.4	25.3	30.2

Table (32): The effect of carboxy methyl cellulose C.M.C. on the cloud stability of single strength orange juice.

Treatments	Transmission %					
	Pre-Storage	Storage period / day on 25°C				
	0	15	30	40	60	75
Pasteurized orange juice control	20.7	24.9	35.5	47.8	58	69
" " " + 1% C.M.C.	4.1	9.5	13.1	18.2	22.3	25.5
" " " + ,7% C.M.C.	7.3	11.4	16.1	21.3	25.2	29.8
" " " + ,5% C.M.C.	9.7	12.1	18.7	27.4	38.1	45
NonPasteurized orange juice control	15.5	23.3	29.8	39.9	45.6	55
" " " + 1% C.M.C.	3.2	8.1	11.9	17.1	20	21.2
" " " + ,7% C.M.C.	6.1	9.9	14.6	18.9	22	23.6
" " " + ,5% C.M.C.	7.5	11.	15.4	23.1	26.2	29.1

Table (33): The effect of Pectin on the cloud stability of single strength orange juice.

Treatment	Transmission %					
	Pre-storage	Storage Period / day on 25°C				
	0	15	30	45	60	75
Pasteurized orange juice control	20.7	24.9	35.5	47.8	58	69
" " " + 1% Pectin	8	14.6	17.5	24	30	45
" " " + ,7% Pectin	10.2	16.2	22.1	31	41	51
" " " + ,5% Pectin	12.3	18.7	25.7	34	45	59
NonPasteurized orange juice control	15.5	23.3	29.8	39.9	45.6	55
" " " + 1% Pectin	6	18.1	16.0	22	28	35
" " " + ,7% Pectin	7.9	14.9	20.2	28.3	35	41
" " " + ,5% Pectin	10	17.0	23.1	30	39.1	48

Table (34): The effect of Arabic gum on the cloud stability of single strength orange juice.

Treatments	Transmission %					
	Pre-storage	Storage Period/day on 25°C				
	0	15	30	45	60	75
Pasteurized orange juice Control	20.7	24.9	35.5	47.8	58	69
" " " + 1% Arabic gum	9	16.7	21	28	35.6	45
" " " + ,7% Arabic gum	11	18.1	26	26	48	57
" " " + ,5% Arabic gum	13	20.2	32.3	41.5	52	61
Non-Pasteurized orange juice control	15.5	23.3	29.8	39.9	45.6	55
" " " + 1% Arabic gum	8	15.1	20	27	33	42
" " " + ,7% Arabic gum	10	17.4	25	33	40	48
" " " + ,5% Arabic gum	12	[illegible]	28	36	44	52

Table (35): The effect of guar gum on the cloud stability of concentrated orange juice.

Treatments	Transmission %					
	Pre-storage	Storage period / day on 25°C				
	0	15	30	45	50	75
Concentrated orange juice control	5.5	10.2	18.3	22.4	24.6	30.6
" " " + 1,5% guar	1.1	1.4	2.8	3.6	4.5	4.8
" " " + 1% guar	1.1	2.1	3.2	3.8	4.4	5.4
" " " + ,7% guar	3.4	3.9	4.5	6.2	7.1	9.8
" " " + ,5% guar	5.6	7.2	8.4	9.5	12.3	15.6

Note: Transmission percent was recorded in reconstituted juice (1 : 4).

Table (36): The effect of guar gum on the chemical properties of single orange juice during storage at 35°C.

Treatments	Total Solids T.S.		Total Soluble Solids T.S.S.		pH		Viscosity		Jel Strength	
	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days
Pasteurized orange juice control	13.20	12.90	12.6	12.3	3.91	4.0	--	--	-	-
" " " + 1% guar	14.80	14.55	14.35	14.10	4.68	4.80	3400	2960	+10	+9
" " " + ,7% "	14.65	14.25	14.30	13.85	4.60	4.70	2860	2440	+9	+8
" " " + ,5% "	14.20	13.80	13.50	13.20	4.44	4.49	1610	1160	+7	+6
Non-pasteurized orange juice control	13.10	12.80	12.5	12.2	3.85	3.91	-	-	-	-
" " " + 1% guar	14.85	14.60	14.59	14.05	4.72	4.88	3800	3102	+10	+10
" " " + ,7% "	14.70	14.45	14.35	13.90	4.65	4.75	2920	2580	+9	+9
" " " + ,5% "	14.35	14.10	13.70	13.55	4.60	4.68	1880	1260	+6	+6

Note P.S.: Pre-storage.

Table (37): The effect of carboxy methyl cellulose on the chemical properties of single strength juice during storage at 25°C.

Treatments	Total Solids T.S.		Total Soluble Solids T.S.S.		pH		Viscosity		Jel Strength	
	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days
Pasteurized orange juice control	13.20	12.90	12.60	12.30	3.91	4.0	-	-	-	-
" " " + 1% C.M.C.	12.60	14.75	14.25	13.95	4.15	4.20	1980	926	+6	+5
" " " + ,7% "	14.30	14.05	13.90	13.35	4.10	4.15	980	640	+5	+5
" " " + ,5% "	13.95	13.60	13.45	13.05	4.05	4.10	620	318	+5	+4
Non-Pasteurized orange juice control	13.10	12.80	12.50	12.20	3.85	3.91	-	-	-	-
" " " + 1% C.M.C.	14.50	14.00	14.15	13.85	4.10	4.16	1266	802	+6	+5
" " " + ,7% "	14.25	13.85	13.65	13.25	4.00	4.68	840	504	+5	+5
" " " + ,5% "	13.90	13.55	13.40	12.90	3.95	4.00	600	310	+5	+4

Note P.S.: Pre-storage.

Table (38): The effect of pectin on the chemical properties of single strength orange juice during storage at 25°C.

Treatments	Total Solids T.S.		Total Soluble Solids T.S.S.		pH		Viscosity		Jel Strength	
	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days
Pasteurized orange juice control	12.30	12.90	12.60	12.30	3.91	4.0	-	-	-	-
" " " + 1% Pectin	14.40	14.05	13.85	13.30	3.45	3.25	440	210	+4	+2
" " " + ,7% "	14.25	13.90	13.64	13.15	3.60	3.50	280	106	+3	+2
" " " + ,5% "	13.80	13.40	13.35	12.75	3.90	9.91	-	-	-	-
Non-Pasteurized orange juice control	13.10	12.80	12.50	12.20	3.85	9.91	-	-	-	-
" " " + 1% Pectin	14.35	14.20	13.60	13.40	3.50	3.55	410	202	+4	+2
" " " + ,7% "	14.20	14.05	13.35	13.05	3.51	3.50	240	104	+3	+2
" " " + ,5% "	13.70	13.45	13.20	!2.95	3.79	3.66	120	68	+2	+1

Note P.S.: Pre-storage.

Table (39): The effect of arabic gum on the chemical properties of single orange juice during storage at 25°C.

Treatments	Total Solids T.S.		Total Soluble Solids T.S.S.		pH		Viscosity		Jel Strength	
	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days
Pasteurized orange juice control	13.70	12.90	12.6	12.30	3.91	4.00	-	-	-	-
" " " + 1% Arabic gum	14.10	13.80	13.55	13.20	4.25	4.11	290	120	+3	+2
" " " + ,7% "	13.90	13.60	13.35	13.60	4.14	4.07	210	106	+3	+2
" " " + ,5% "	13.60	13.20	12.90	12.40	4.08	4.02	180	80	+3	+1
Non-Pasteurized orange juice control	13.10	12.80	12.50	12.50	3.85	3.91	-	-	-	-
" " " + 1% Arabic gum	14.0	13.70	13.50	13.15	4.30	4.24	260	114	+3	+2
" " " + ,7% "	13.80	13.55	13.25	12.95	4.25	3.15	210	102	+3	+2
" " " + ,5% "	13.50	13.25	12.91	12.35	4.15	3.10	140	70	+2	+1

Note P.S.: Pre-storage.

4.2.2. Tomato Juice:

As tomato juice was severely subjected to rapid separation of serum from the colloidal substances after a while of squeezing and along the coming storage, It was of great important to overcome this problem by trying to thickening the jjice in a way to be stablihzed during storage. Results in Tables (41-49), showed the effect of guar, C.M.C., Pectin and arabic gum as a thickening agent on the cloud retention of tomato juice. Like orange juice; the guar gum affect positively the stability of tomato juice and was proportionally lineard with concentration. The transmission percent was decreased by increasing the guar concentration.

It could also be noticed, that non pasteurized juice recorded high transmission than pasteurized juice; which was opposite to those recorded by orange juice. This was due to the different composition of both juices, which indicate that orange juice contain more colloidal substances susceptable to precipitate by heat treatment, or may be due to the highly pectin substance exist in tomato juice. The concentration of the thickening agent showed to play important role in stabilizing the cloud stability; being more effective with 1% followed by 0.7% and 0.5%. Opposite to orange juice; Pectin showed to be effective in stabilizing tomato juice than guar gum which come the second in sequence, followed by C.M.C. and arabic gum. These results may be due to the nature of tomato juice which has the ability to response with pectin more than any other thickening agent. The storage period also affect the stability of the juice as the transmission increase steadily by increasing storage although it was lower in case of pectin, followed by guar gum, C.M.C. and arabic gum. Results in tables (45-48) showed the effect of thickening agents on the physical and chemical properties of tomato juice during storage.

As it is clear, the viscosity was linearly related to the concentration of the thickening agent, although there was a great difference in viscosity recorded in each thickening agent. Results showed that the viscosity in case of pectin agent recorded the highest value, followed by guar gum, C.M.C., and the lowest viscosity was the arabic gum. Also the jel strength which reflect the state of consistency of the juice was the highest with pectin agent, followed by guar gum, C.M.C. and the lowest strength obtained was with arabic gum. The chemical constituents during storage Tables (45-48) did not show a significance change which indicate that these agent has any effect on the chemical composition and subsequently could be safely used in any food stuff.

From the obtained results we could conclude that pectin in ratio of 1% is proper thickening agent for maintaining the cloud stability of tomato juice, while guar in a concentration of 1% is the best agent for orange juice.

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Table (41): The effect of guar gum on the cloud stability of Tomato juice.

Treatments	Transmission %					
	Pre-storage	Storage period / day on 25°C				
	0	15	30	45	60	75
Pasteurized tomato juice control	28.2	34.6	41.2	53.1	64.2	75
" " " + 1% guar	5.1	7.8	10.1	14.2	17.1	20
" " " + ,7% guar	8.4	10.3	14.6	18.2	21.4	25
" " " + ,5% guar	13.1	17.2	23.1	31.2	36.1	40
NonPasteurized tomato juice Control	35.3	46	57.2	68	74.1	80
" " " + 1% guar	10.2	14.7	19.1	23.1	25.5	28.6
" " " + ,7% guar	14.3	18.6	22.7	28.4	30.1	32.1
" " " + ,5% guar	18.9	24.2	28.5	36.5	41.2	45

Table (42): The effect of carboxy methyl cellulose on the cloud stability of Tomato juice.

Treatments	Transmission %					
	Pre-storage	Storage period / day on 25°C				
	0	15	30	45	60	75
Pasteurized tomato juice Control	28.2	34.6	41.2	53.1	64.2	75
" " " + 1% C.M.C.	8.1	10.4	14.9	19.2	23.1	27
" " " + ,7% C.M.C.	11.2	14.3	17.9	22.8	29.1	33
" " " + ,5% C.M.C.	14.3	19.6	24.4	32.9	41.9	50
NonPasteurized tomato juice Control	35.3	46	57.2	68	74.1	80
" " " + 1% C.M.C.	11.4	17.6	24.2	28.3	30.1	32
" " " + ,7% C.M.C.	13.6	19.5	26.1	31.2	33.1	36
" " " + ,5% C.M.C.	15.1	22.1	29.4	36.1	45	55

Table (43): The effect of Pectin on the cloud stability of Tomato juice.

Treatments	Transmission %					
	Pre-storage	Storage period / day on 25°C				
	0	15	30	50	60	75
Pasteurized tomato juice Control	28.2	34.6	41.2	53.1	64.2	75
" " " + 1% Pectin	4.6	6.2	9.1	12.9	15.9	18
" " " + ,7% Pectin	7.3	9.4	13.2	17.5	19.2	21
" " " + ,5% Pectin	11.1	16.4	22.1	30.5	34.2	35
NonPasteurized tomato juice Control	35.3	46	57.2	68	74.1	80
" " " + 1% Pectin	15	19.4	23.1	26.2	28.3	30
" " " + ,7% Pectin	20	25.3	27.8	29.4	33.2	36
" " " + ,5% Pectin	28	30.4	36.2	41.1	45.5	50

Table (44): The effect of Arabic gum on the cloud stability of Tomato juice.

Treatments	Transmission %					
	Pre-storage	Storage period / day on 25°C				
	0	15	30	45	60	75
Pasteurized tomato juice Control	28.2	34.5	41.2	53.1	64.2	75
" " " + 1% Arabic gum	14.2	16.4	25.8	36.1	44.2	55
" " " + ,7% Arabic gum	16.1	18.2	27.4	39.1	48.1	59
" " " + ,5% Arabic gum	20.0	22.3	30.1	42.4	54.2	65
NonPasteurized tomato juice Control	35.3	46	57.2	68	74.1	80
" " " + 1% Arabic gum	15.6	18.1	29.1	4.0	52	61
" " " + ,7% Arabic gum	18.3	24.6	33.1	45.0	54.6	59
" " " + ,5% Arabic gum	22.4	27.1	38	49.0	62	74

Table (45): The effect of guar gum on the chemical properties of tomato juice during storage on 25°C.

Treatments	Total Solids T.S.		Total Soluble Solids T.S.S.		pH		Viscosity		Jel Strength	
	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days
Pasteurized tomato juice control	7.5	6.65	6.30	6.05	4.15	4.25	-	-	-	-
" " " + 1% guar	8.90	8.60	8.65	8.25	5.15	5.25	2960	2202	+9	+8
" " " + ,7% "	8.40	8.15	8.00	7.75	5.10	5.20	2610	1912	+8	+7
" " " + ,5% "	7.90	7.40	7.30	6.90	4.95	5.05	1940	1010	+7	+6
Non-Pasteurized tomato juice control	6.75	6.60	6.00	5.75	4.41	4.50	-	-	-	-
" " " + 1% guar	8.80	8.50	8.60	8.05	5.05	5.10	2720	2020	+9	+8
" " " + ,7% "	8.30	8.10	7.80	7.25	5.00	5.07	2360	1860	+8	+7
" " " + ,5% "	7.95	7.35	7.30	6.95	4.90	4.99	1812	986	+7	+5

Note P.S.: Pre-storage.

Table (46): The effect of carboxy methyl cellulose on the chemical properties of tomato juice during storage on 25°C.

Treatments	Total Solids T.S.		Total Soluble Solids T.S.S.		pH		Viscosity		Jel Strength	
	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days
Pasteurized tomato juice control	7.05	6.75	6.30	6.00	4.15	4.25	-	-	-	-
" " " + 1% C.M.C.	8.4	8.15	7.9	7.65	4.58	4.50	1280	790	+6	+5
" " " + ,7% "	8.2	7.95	7.1	7.20	4.45	4.45	986	584	+5	+5
" " " + ,5% "	7.7	7.20	7.2	6.80	4.41	4.37	603	310	+5	+4
Non-Pasteurized tomato juice control	6.95	6.50	6.00	5.70	4.41	4.50	-	-	-	-
" " " + 1% C.M.C.	8.35	8.00	7.75	7.55	4.60	4.55	1118	714	+6	+5
" " " + ,7% "	8.15	7.80	7.35	7.15	4.50	4.41	890	420	+5	+4
" " " + ,5% "	7.60	7.20	6.90	6.60	4.49	4.40	610	312	+6	+4

Note P.S.: Pre-storage.

Table (47): The effect of pectin on the chemical properties of tomato juice during storage on 25°C.

Treatments	Total Solids T.S.		Total Soluble Solids T.S.S.		pH		Viscosity		Jel Strength	
	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days
Pasteurized tomato juice control	7.05	6.65	6.30	6.00	4.15	4.25	-	-	-	-
" " " + 1% Pectin	8.80	8.75	8.71	8.35	3.54	3.35	3012	2260	+10	+8
" " " + ,7% "	8.70	8.45	8.25	7.80	3.72	3.42	2960	2116	+9	+8
" " " + ,5% "	8.20	7.85	7.60	7.25	3.91	3.47	2004	1104	+8	+6
Non-Pasteurized tomato juice control	6.95	5.50	6.00	5.70	4.41	4.50	-	-	-	-
" " " + 1% Pectin	8.90	8.60	8.45	8.05	3.65	3.49	2840	1990	+9	+7
" " " + ,7% "	8.60	8.25	7.9	7.40	3.75	3.52	2420	1720	+8	+1
" " " + ,5% "	8.15	7.80	7.55	7.20	3.80	3.60	1640	880	+7	+5

Note P.S.: Pre-storage.

Table (48): The effect of Arabic gum on the chemical properties of tomato juice during storage on 25°C.

Treatments	Total Solids T.S.		Total Soluble Solids T.S.S.		pH		Viscosity		Jel Strength	
	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days	P.S.	After 75 days
Pasteurized tomato juice control	7.05	6.65	6.70	6.00	4.15	4.25	-	-	-	-
" " " + 1% Arabic gum	7.95	7.60	7.40	7.05	4.40	4.46	240	124	+3	+2
" " " + ,7% "	7.30	6.90	6.70	6.30	4.39	4.41	196	118	+3	+7
" " " + ,5% "	7.05	6.65	6.40	6.05	4.28	4.33	140	86	+2	+1
Non-Pasteurized tomato juice control	6.95	6.50	6.00	5.70	4.41	4.50	-	-	-	-
" " " + 1% Arabic gum	7.85	7.54	7.25	6.85	4.33	4.37	220	114	+3	+2
" " " + ,7% "	7.25	6.55	6.55	6.20	4.27	4.32	180	102	+3	+2
" " " + ,5% "	7.00	7.45	6.40	5.95	4.21	4.25	120	66	+2	+1

Note P.S.: Pre-storage.

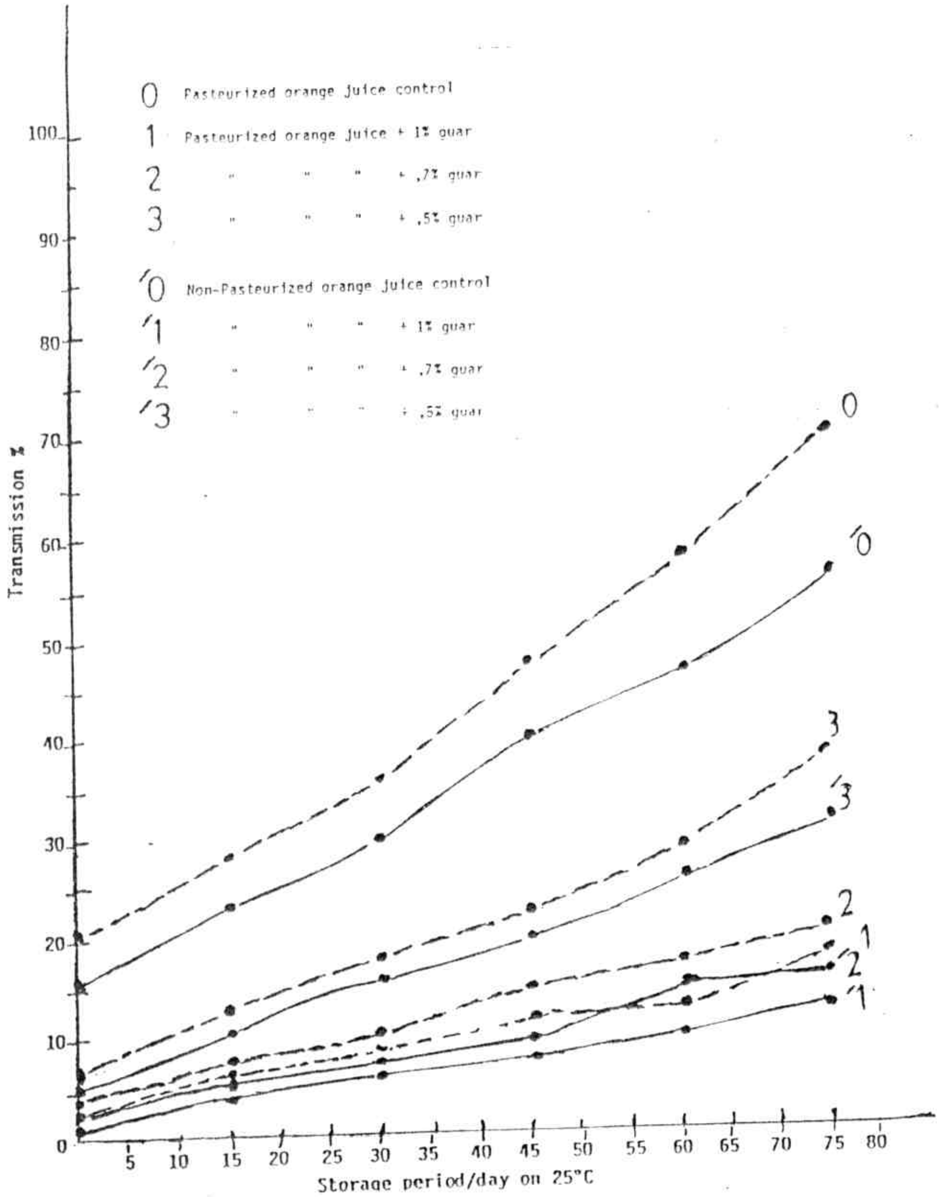

Fig. (26): The effect of guar gum on the cloud stability of single strength orange juice.

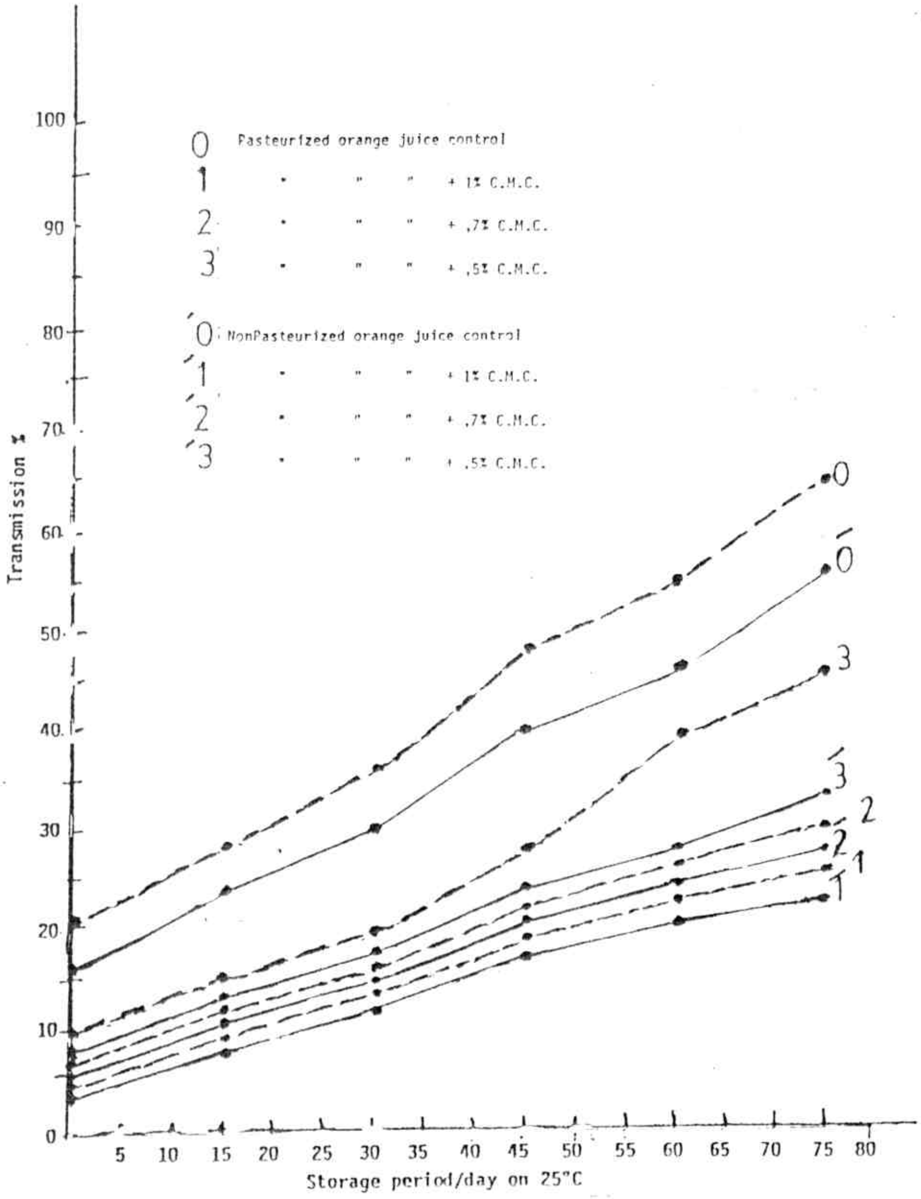

Fig. (27): The effect of carboxy methyl cellulose on the cloud stability of single strength orange juice.

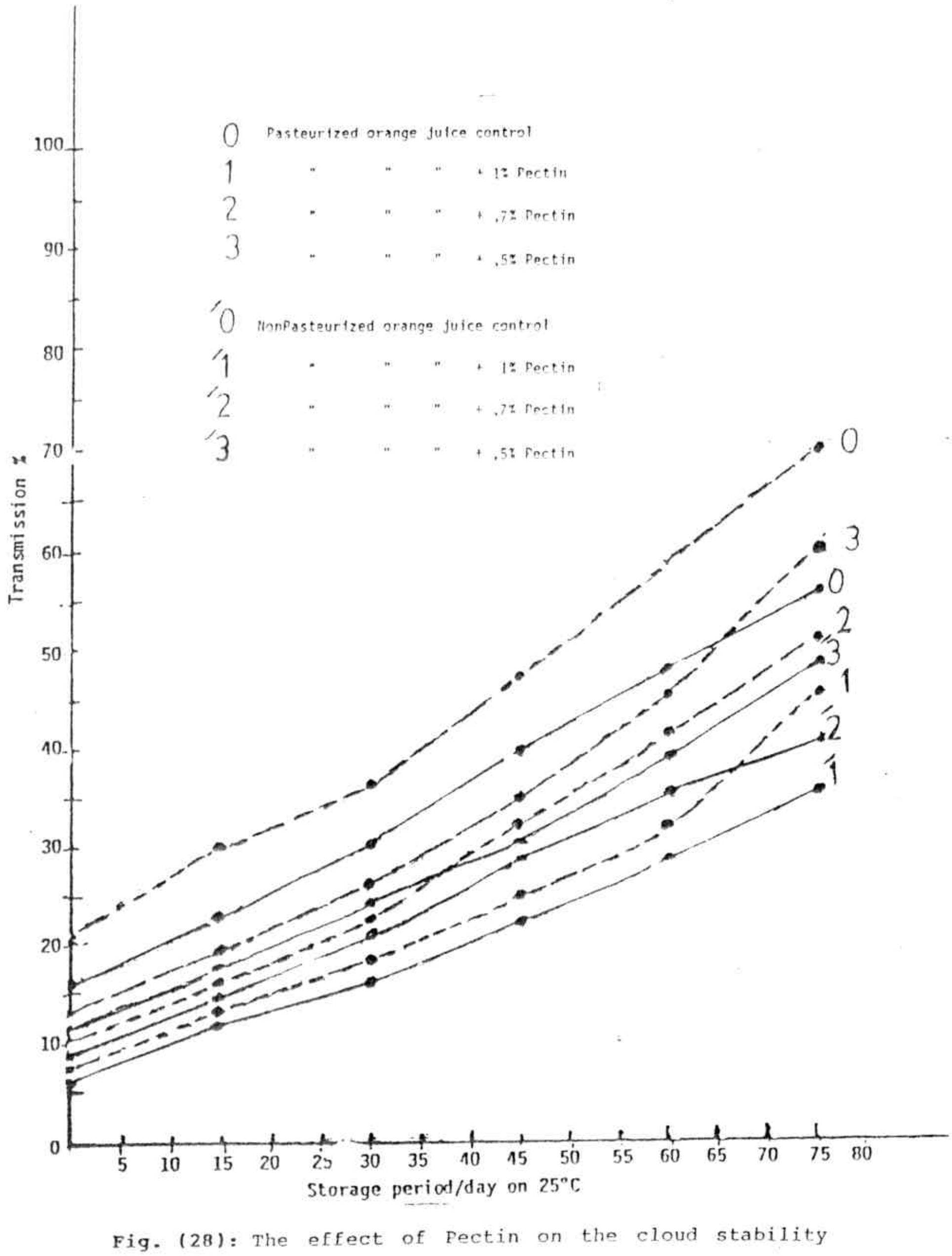

Fig. (28): The effect of Pectin on the cloud stability of single strength orange juice.

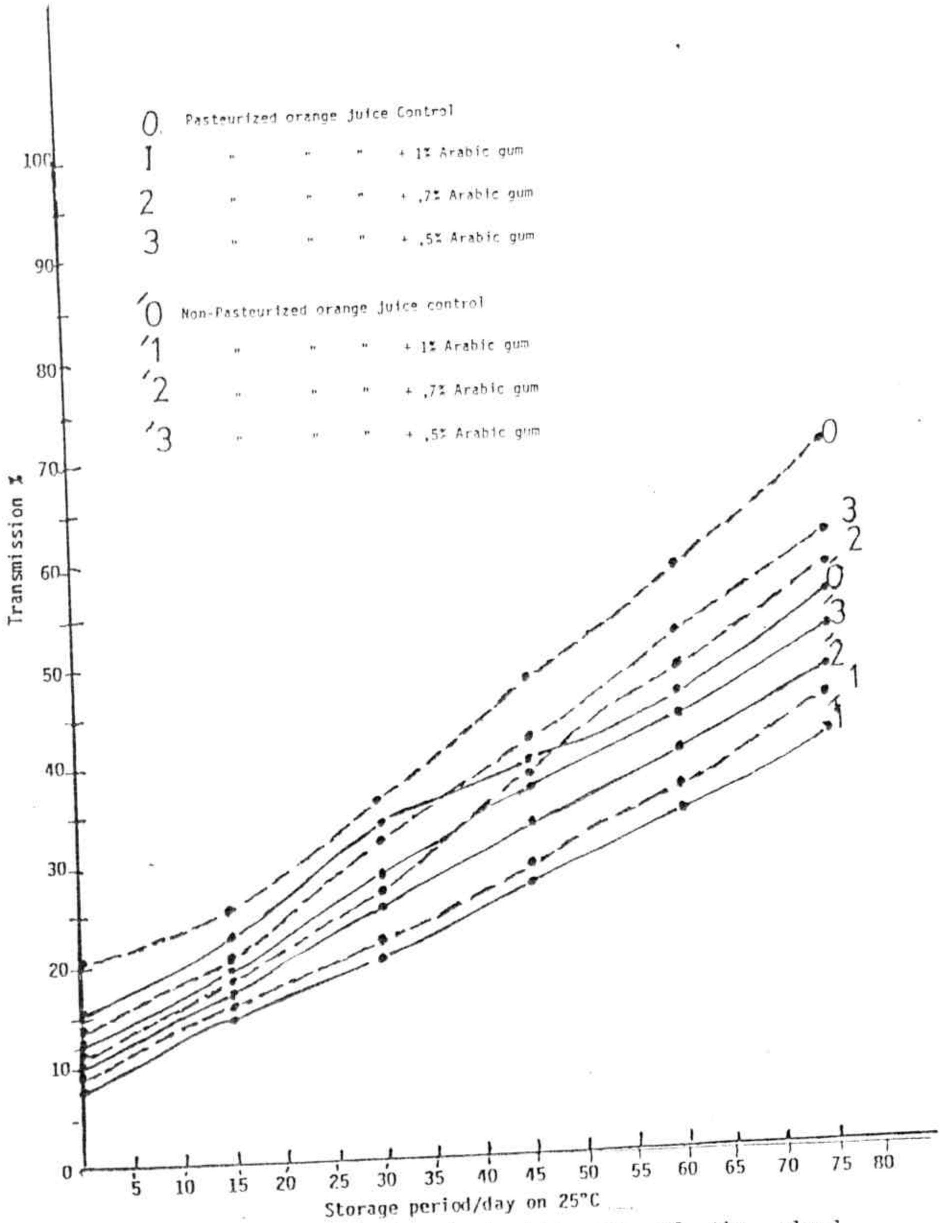

Fig. (29): The effect of Arabic gum of the cloud stability of single strength orange juice.

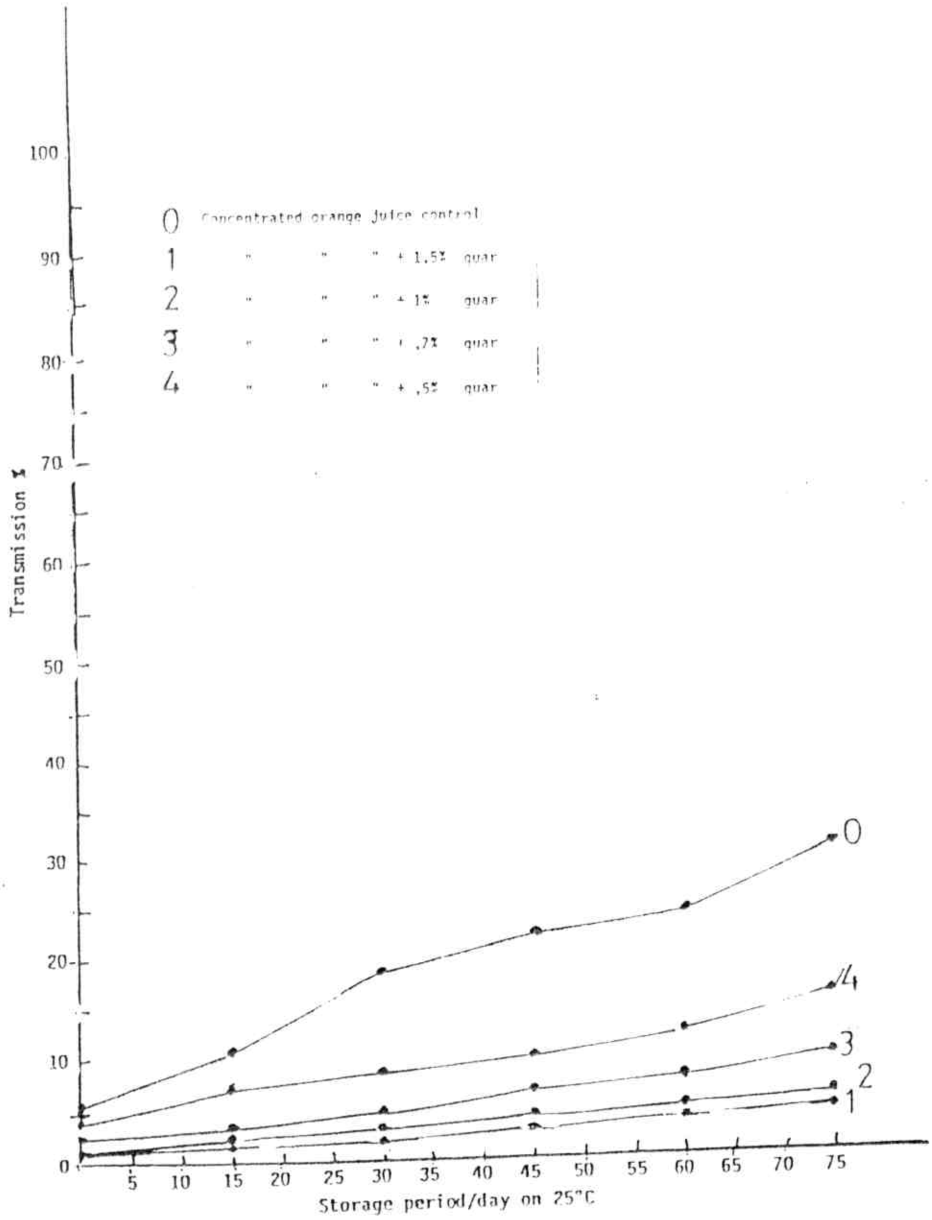

Fig. (30): The effect of guar gum on the cloud stability of concentrated orange juice.

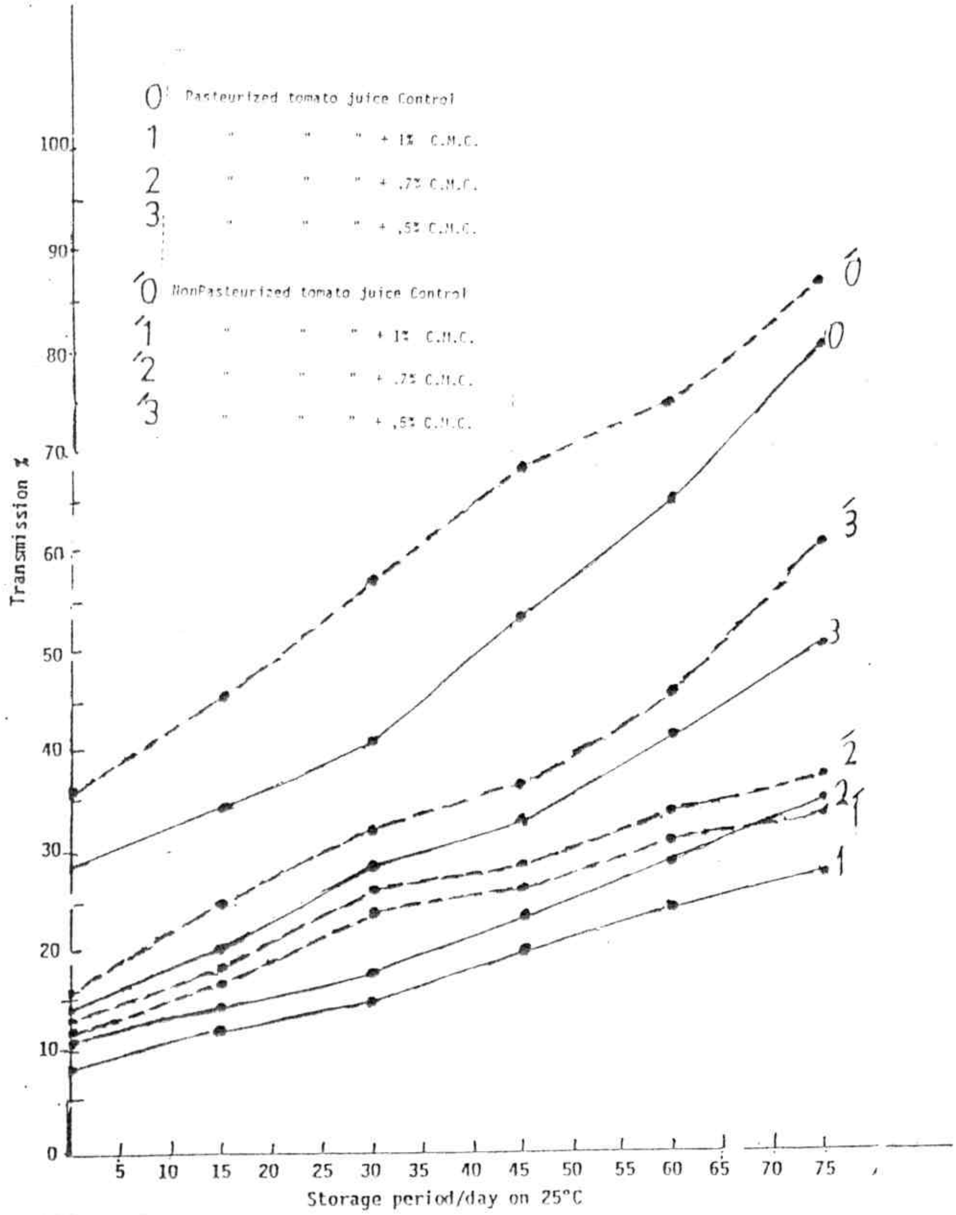

Fig. (32): The effect of carboxy methyl cellulose on the cloud stability of single strength tomato juice.

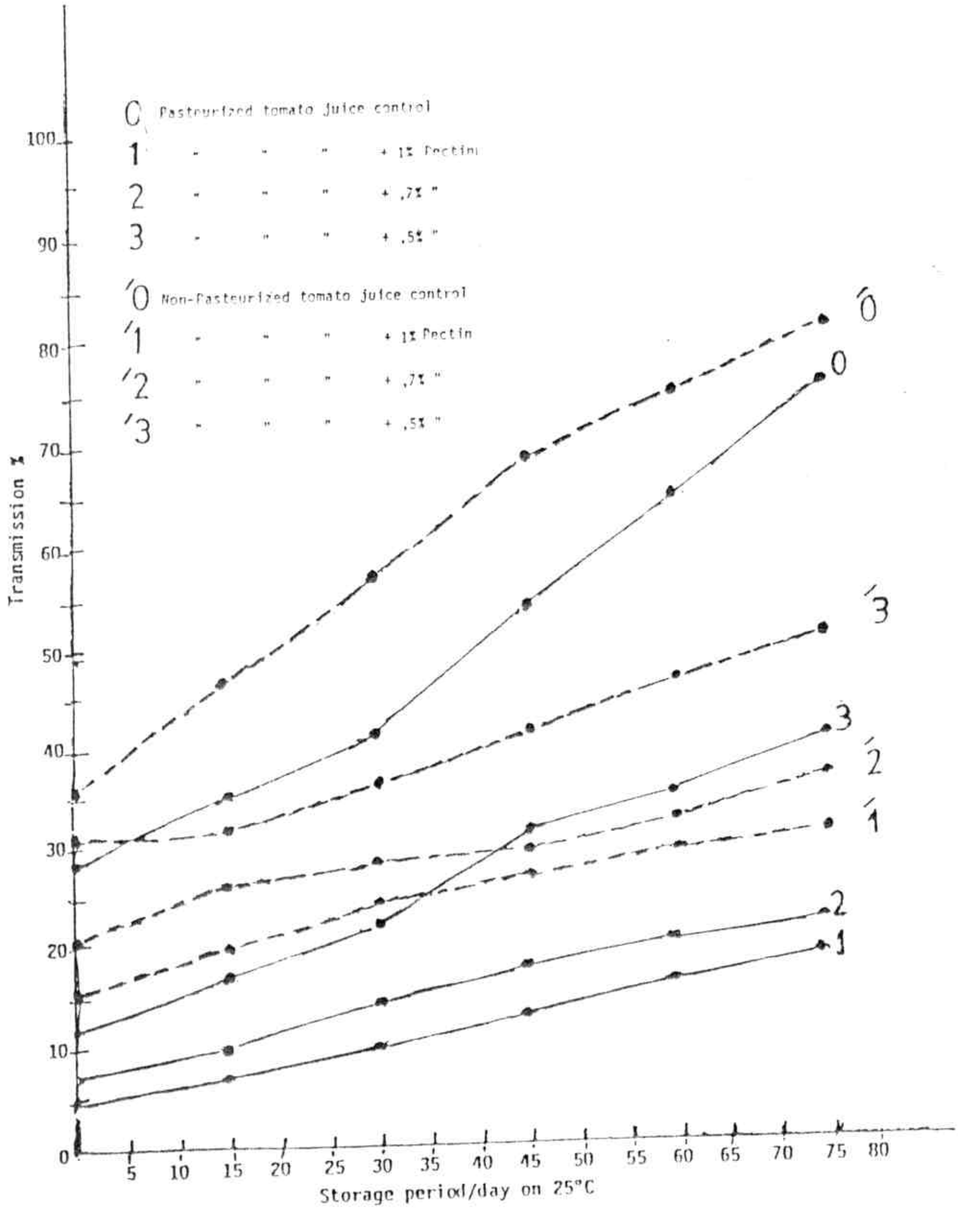

Fig. (33): The effect of Pectin on the cloud stability of single strength tomato juice.

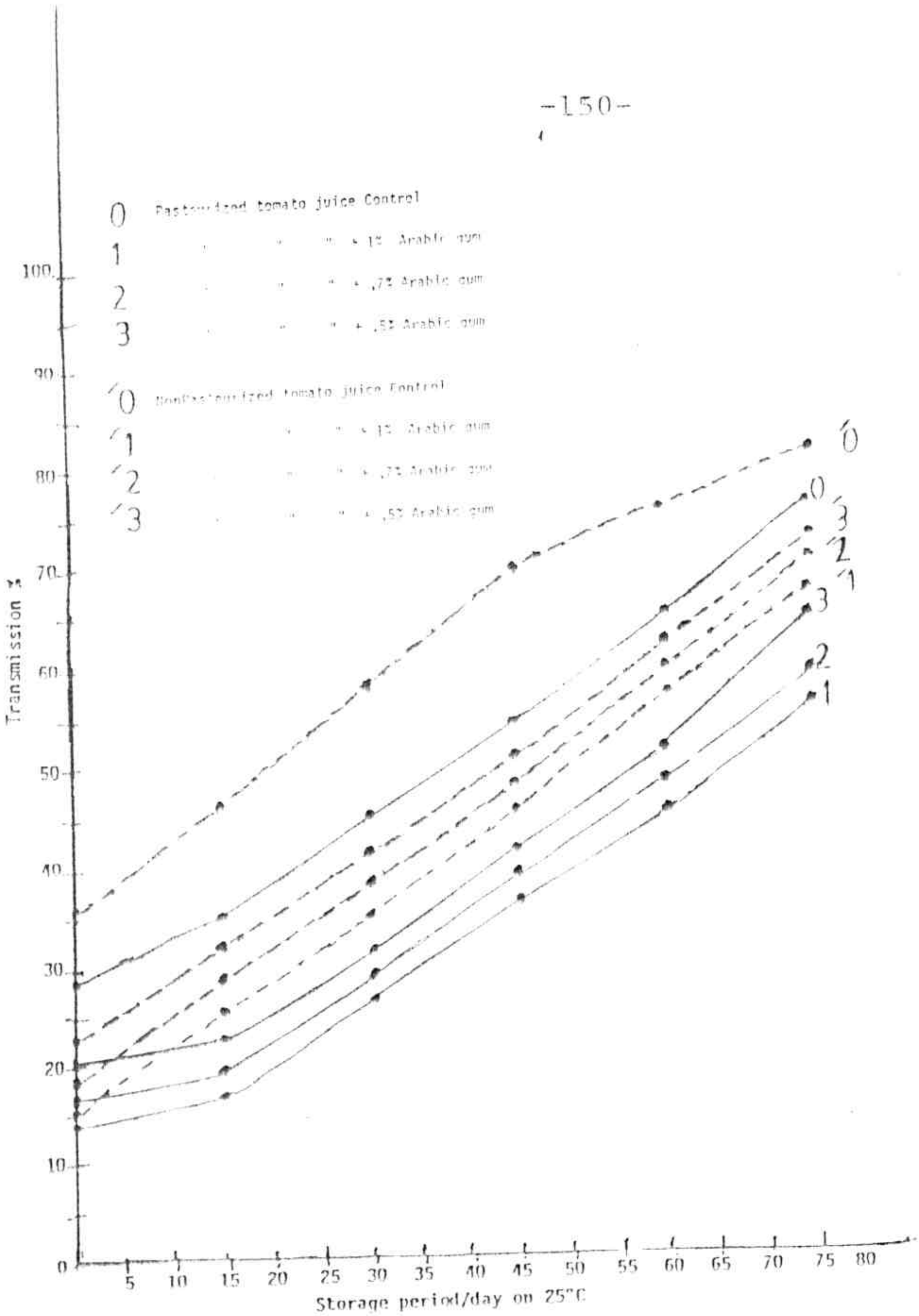

Fig. (34): The effect of Arabic gum on the cloud stability of single strength tomato juice.