Studies on some low-lactose milk products

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The importance of milk and its products are very wellconsidered for infants and adults from the nutrional and healthpoint of view. However, low-lactose milk and/or its products isof great importance for sensitive and intolerant consumers to theordinary milk and its products.This study was planned to produce purified B-galactosidaseenzyme from K. lactis yeast which immobilized through cellulosefabric strips , and used in making low lactose milk and some otherlow lactose dairy products. Moreover, low lactose ultrafitratedmilk was used in prepanng low lactose ice cream, yoghurt andwhite soft cheese.The investigation was carried out in three parts.Part I : Production orB-galactosidase enzyme from K. lactisand its properties:Section A This section deals with the suitable andfovourable conditions for biosynthesis and cell free extraction of~-galactosidase enzyme. The results can be summarized asfollows : 1- The obtained supernatant f3-galactosidase activity, proteincontent as well as specific activity increased continuously asth~.)nocubation period increased fromwhere the highest enzyme activity was achieved.Afterwards, there was slight continous decrease.2- The highest activity was attained at 30°C , PH 4.8 andinoculum size of 1.0% (v/v).3- The sonication period to give the optimum activity of theenzyme was 10 min.Section Band C: Purification and chaterization of K. lactis 13-galactosidase.Results could be summarized as follows :1. Crude J3-galactosidase enzyme performed from sonicationyeast was partially purified by acetone precipitation. The bestratio was found to be 1 : 1 (v/v) at 4°C as it gave the highestvolume of activity, specific activity and purfication fold of 2.6.The final purification of the enzyme was achieved using Gelfiltration on Sephadex G.2DD and sodium phosphate buffer forelution at pH 6.5.Studying the properties of crude and purified enzymeindicated that :* Assay time of the enzyme was 5 min for both of crude andpurified enzyme.optimum temperature was 40°C, while the optimum PH was6.5 for both crude and purified enzyme.The enzyme was activated by Ca++, Mg++,Mn++and K+ ,while Z++ , Fe+++, and Cu++ cations were considered asinhibitors for the enzyme activity.* The crude and purified enzyme were stable at - 1DoC for 14weeks.The kinetic parameters of the purified K. lactis pgalactosidaseshowed that the Michaelis Menten constant(Km) was 1.2 UM and the Vmax was 8.4 mole unit/mgprotein/ minute.Part II :Immobilization of K. lactis B-galactosidase enzyme oncellulose fabric strips and its e((eciency in hYdrolysinglactose.Pilot experiments were conducted to evaluate the effeciencyand capability of cellulose fabric strips for immobilization of Betagalactosidase enzyme. The results can be summarized as follows:-1- Some experiments were carried out to achieve the optimumhydrolysis for 6 runs. Latose hydrolysis was estimatedquantitavely in each run through the Osazone fraction.2- Evaluating the validity of reusing the immobilized 13-galactosidase cellulose fabric strips indicates that areasonable percentage of lactose hydrolysis could be achievedby using such strips for two or three times.3- The effeciency of lactose hydrolysis by immobilized 13-galactosidase cellulose fabric strips was evaluated by comparingwith soluble enzyme. This was applied on lactose (5%) aqueoussolution and pasteurized skim milk for 6 h or runs. Therefore theresults concluded that :* Lactose hydrolysis in 5% lactose solution was almost similarwhen using soluble or immobilized strips for the first 3 h orruns. However, using soluble enzyme gave a slight increase inhydrolysis through the last 2 h or runs.* Immobilized enzyme was more effecient in hydrolysing lactoseof skimmilk than soluble enzyme.Part III :Manufacturing of low lactose Dairv products:Section A: Low lactose Ice CreamLow lactose Ice

cream was prepared from UF whole milkretentate (diluted with water with ratio (l: 1) and immobilized milkand they compared with that made from whole buffalo milk. Thecomposition and properties of the mixes as well as the resultantice cream were studied and the data obtained can be summarizedas follows:1. Fat content of mixes was standardized to be 6%~ lactosecontent was 5.0, 2.1 and 2.3% for the control, immobilizedand UF-retentate mixes respectively. The respective proteincontent was 4.0~ 4.2 and 5.7%, while the T.S. was 32.28,32.5 and 32.10% .2. Hydrolysis of lactose increased the acidity and decreased thePH of the mix.3. Specific gravity and related weight /gallon as well asviscosity of the UF-treated mix were higher than theimmobilized treatment which in turn higher than the control.4. Hydrolysis of lactose by the immobilized enzyme lowered thefreezing point of the mix, while decreasing the lactose by UFtreatment caused high freezing point than the control mix.5. Specific gravity and its corresponding weight/gallon of theice cream were the highest in UF treatment, followed byimmobilized milk treatment and at last comes the controltreatment.6. The overrun was the highest in control (65.94%) followed bythe immobilized treatment (52.350/0), Then the UF treatment(47.91 %).7. Milting resistance of ice cream made from UF retentate was thehighest, then control, at last was the ice cream made fromimmobilized milk.8. Organoleptic tests of ice cream showed that the increase ofprotein and low lactose contents in UF - treatment recipeimproved body and texture of the resultant ice cream. Whilethe hydrolysis of lactose by the J3-galactosidase enzymeincreased its sweetness.So, the results proved the validity of using immobilized milkand UF -retentate to increase the milk SNF without sandiness andto give a good quality ice cream.Section B: Low Lactose Yog.",tThree treatments of yoghurt were prepared frombuffaloes'milk as a control, diluted UF- retentate (1 :1 w/w) andpartly hydrolysed lactose milk by immobilized fl-galactosidaseenzyme.The chemical composition of buffaloes'milk, diluted UFretentateand immobilized milk showed that the UF retentate waslow in T.S., S.N.F, lactose, fat, acidity content, but it was high inprotein content, while the immobilized-milk resembled thecomposition of buffaloesmilk except the reduction in lactosecontent.Concerning yoghurt, results revealed that:I. The hydrolysis of lactose in the immobilized treatment causedan acceleration in the developed acidity during processingand storage, while the UF treatment showed a decrease inacidity development. The pH took the trend of acidity but inan opposite direction.2. Curd tension of yoghurt was almost affected with acidity andTS. Thus, it was low in the UF-treatment than the othertreatments.3. Continuous decrease in lactose content during processing andstorage was observed in all treatments.4. Yoghurt of immobilized milk had the highest acetaldehydecontent, followed by that of buffalo milk and at last yoghurtof 50% retentate. There was a decrease in acetaldehydecontent during storage.5. Lactic acid bacterial count increased in all treatments duringincubation and storage up to the 3rd day, afterwhich it beganto decrease gradually. Almost the total bacterial count wasthe highest in immobilized treatment and the lowest in UFtreatment.6. The organoleptic evaluation proved the possibility of makinga good quality low lactose yoghurt from immobilized milk,while decreasing lactose content by diluting UF retentatecaused some defects in the resultant yoghurt compared withcontrol.Section C: Low Lactos white soft cheese:Lowering lactose content of cheese milk of white softcheese and its effect on the resultant product was the ultimatetarget of this study. Therefore, white soft cheese was made fromretentate diluted with water at concentration of 80% and 50% andcompared with that from buffaloesmilk. The result indicated that:1. The chemical composition of cheese milk revealed that 80%retentate was of the highest percentages of all constituentsexcept lactose content. The 50% retentate was almost similarto control except lactose content.2. Lactic acid bacterial count as well as total count were thehighest in the control, followed by the 80% retentate and atthe last came the 50% retentate when fresh. Substantialcontinuous reduction was noticed for the three treatments asstorage duration period proceeded.3. Curd tension widely varied ammong the three treatments ofcheese. The highest curd tension was for the controlfollowed by the 80% retentate cheese, then the 50% retentatecheese. This result matches well with the behaviour ofacidity content.4. Results revealed differencess in the gross components (T. S.,fat, lactose, T.N.) of the various treatments due to thevariations in the cheese milk composition.5. Fresh cheese made from 80% retentate contained the highestamount of SN , tryptophan and tyrosine, followed by thatmade from 50% retentate afterwhich was the control cheese.During storage , all these parameters increased due thebrotein breakdown with different

rates.6. Organoleptic scoring of fresh cheese indicates the superiorityof control compared with the other two treatments. However,the scoring for the consequent last three week’s showed animprovement in the quality of the control and 80% retentatecheese as they approached in scoring points, while the cheesemade from 50°A.retentate imparted some defects.