RESULTS

V RESULTS

The present study was undertaken to develop a "cheese cake like product" with soybeans as the starting material. As outlined in the Experimental Plan (Fig 4.1) this was carried out in three successive phases. In the first phase of experimentation, specific processes and procedures were established for the conversion of soybean to cheese cake. The modification of preparation and the methods for improving product characteristics were studied in the second phase. The final phase was concerned with the characterisation of standardised products in terms of chemical composition, and estimating their shelf-life under selected packaging and storage conditions. The results of these studies are presented in this section under following heads:

5.1 Preparation of cheese cake from soybean

5.2 Effect of various additives and treatments on product quality

5.3 Characterisation of developed products in terms of composition, microbiological and shelf-life aspects.

5.1 Preparation of cheese cake from soybean

Traditional process for making cheese cake from milk involves the conversion of milk to curd, draining of whey from

curd to obtain muska, and blending of sugar, flavour, and other ingredients such as cream, etc., with muska, followed by a heat treatment for the setting of the final clotted product. Similar approach was followed in the preparation of cheese cake from soybeans, as outlined in Methods and Material Section (Chapter IV Page no. 4.4).

The conversion of milk to curd is usually attained, either by isoelectric casein curd formation mostly through lactic acid fermentation, or by paracasein curd formation through the use of suitable proteolytic enzymes. Considering the advantages of lactic fermentation in the enhancement of flavour and overall acceptability of fermented products, lactic fermentation was utilised in the preparation of soycurd. Although there are various pure cultures available for a wide variety of fermented products such as dahi,yoghurt and cheese, the suitability of these dairy cultures, particularly those used commercially for dahi (curd) required to be studied for the fermentation of soymilk.

5.1.1 Conversion of soymilk to soycurd with commercial "dahi" samples

Mixed lactic cultures in the form of curd samples obtained from five different commercial sources were propagated in

Reconstituted Skimmed Milk (RSM), containing 9 % Total Solids (TS), and added at 1 % level to soymilk, containing 5 % added RSM (as a source of lactose) and incubated at 32°C and 40°C for 14 hours. The effect on curd forming properties were studied interms of :

5.1.2 Developed titratable acidity and pH

5.1.3 Effect on curd strength, and

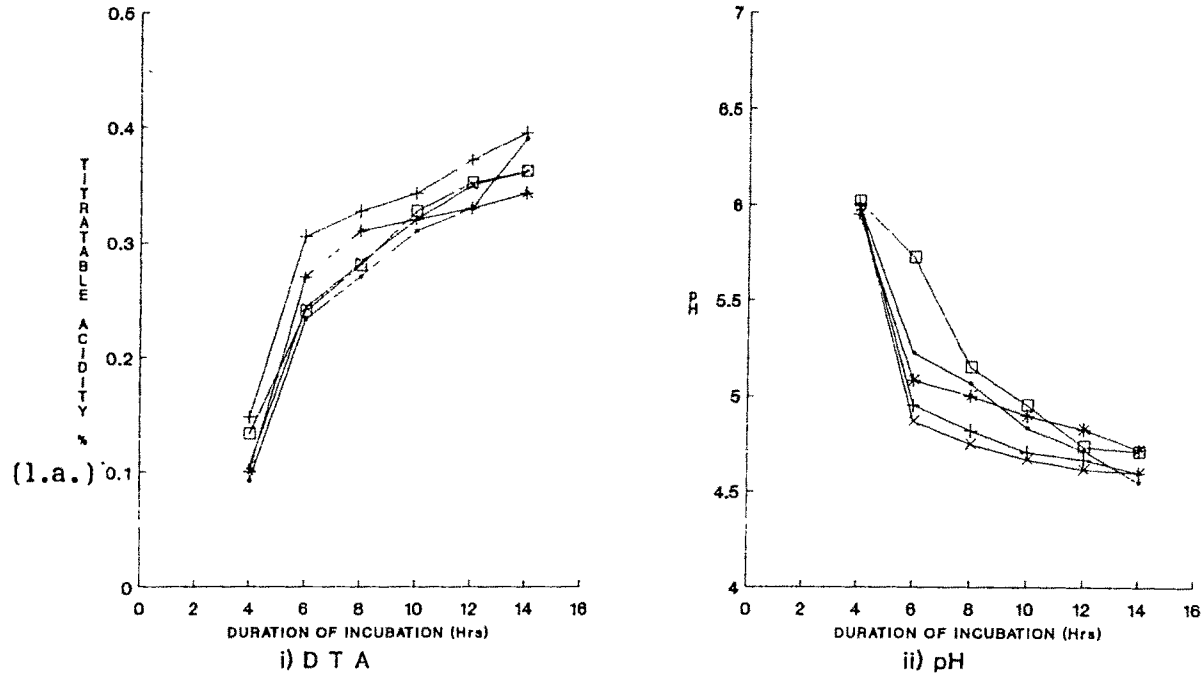
5.1.4 Effect on synerisis

Detailed data pertaining to this aspect of the study is presented in Ap.no. 9.1 - 9.4.

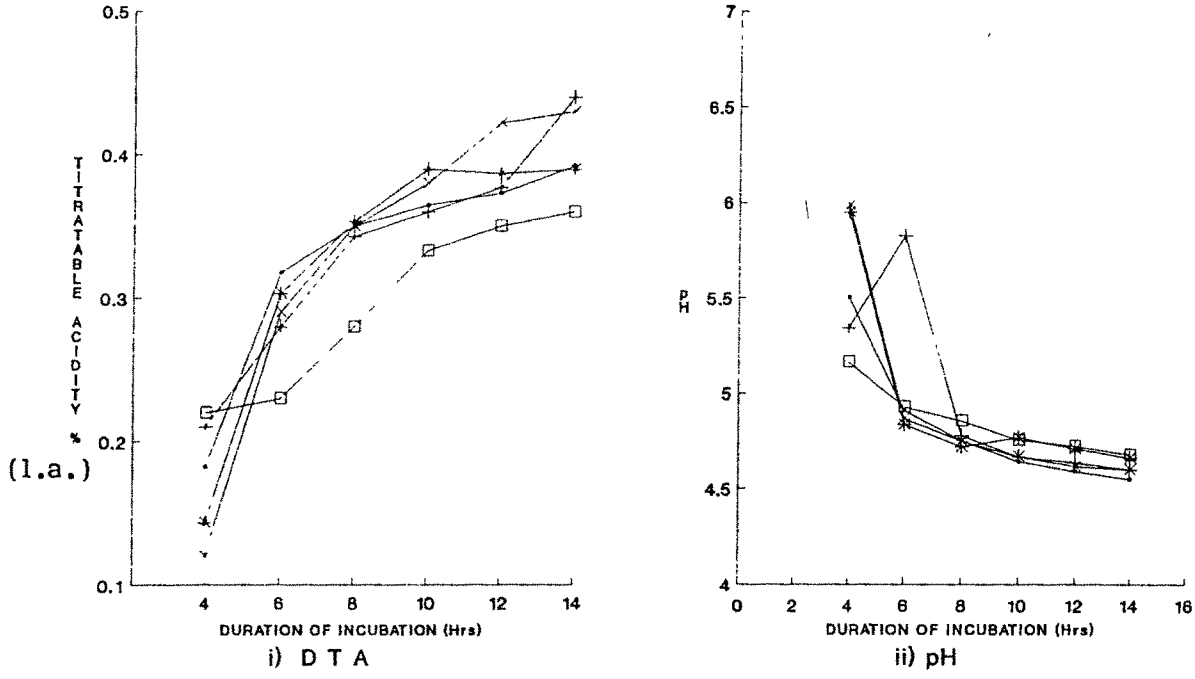
5.1.2 Developed Titratable Acidity and pH

Improvement in flavour and acceptability characteristics of lactic fermented products is mainly related to the quantity of acid developed along with other volatile compounds produced. Titratable acidity and pH of the curd were monitored at 2 hour intervals, during the 14 hours of incubation period and the results on Developed Titratable Acidity (DTA) and pH are presented in Fig 5.1 (a-i & a-ii) and Fig 5.1 (b-i & b-ii).

As can be seen from Fig 5.1 (a-i & b-i), DTA increased in case of all the five cultures to 0.35 to 0.45 % lactic acid (l.a)



a. EFFECT AT 32°C INCUBATION.



b. EFFECT AT 40°C INCUBATION

Figure 5.1 : Effect of different dahi cultures on Developed Titratable Acidity (DTA) and pH.

Culture Used — source I — source II — source III — source IV — source V

as the fermentation progressed. Titratable acidity developement was slightly higher with curds incubated at 40°C than those incubated at 32° C. Regardless of the incubation temperatures, culture from source II and V were found to produce maximum DTA of 0.4-0.45 % l.a. (Fig 5.1 a-i & b-i) after 14 hours of incubation. However, no statistically significant difference was noticed in the acid production behaviours of the five cultures.

Alongwith the progress of fermentation, pH decreased in general, from 6.9 to 4.6 in 10 hours and remained somewhat unchanged for the remaining period of 14 hrs incubation (Fig 5.1 a-i-ii & b-i-ii).

5.1.3 Curd Tension

Strength of the curd reflect the state of coagulation of milk, which inturn determines the yield and the textural quality of the final product. With soymilk systems, curd setting with maximum acid production is attained generally by 8 hrs of incubation (Pinthong *et al.*, 1980a). Curd strength of fermented soymilk was measured, using curd tension knife, during the incubation period of 8 to 14 hours, at 2 hour interval. Curd strength data are presented in Fig 5.2 (a & b).

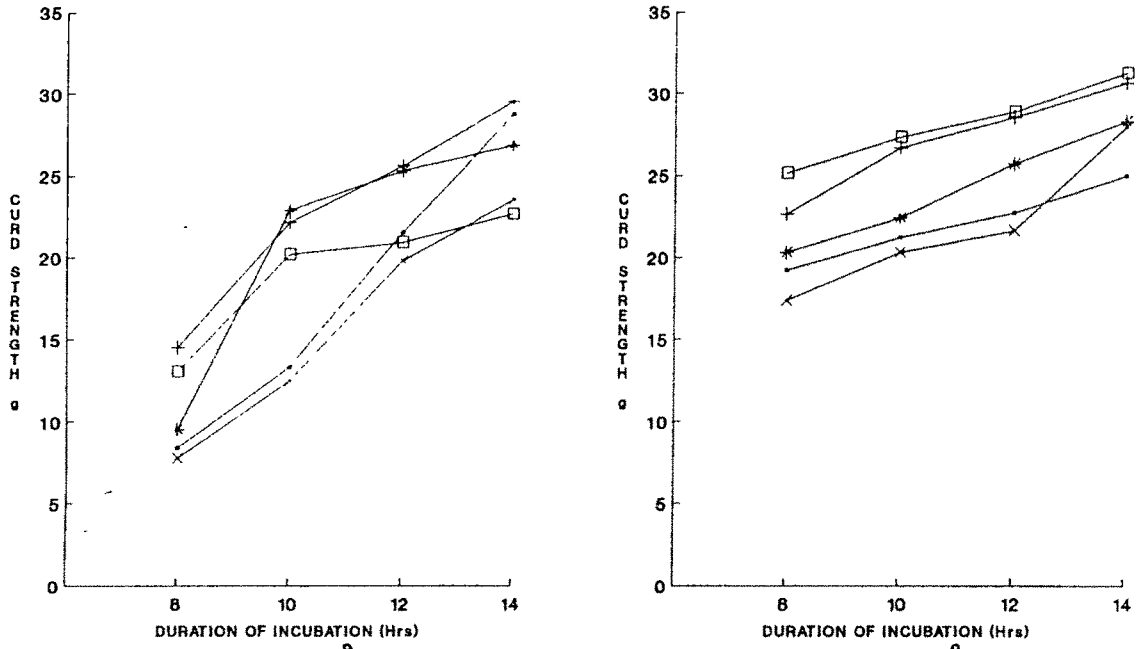


Figure 5.2 Effect of different dahi cultures on curd strengh

As the fermentation progressed from 8 to 14 hours, the firmness of the curd also increased. At the end of 14 hours, incubation temperature of 40°C produced slightly firmer curds, compared to those obtained at 32°C. Of the five culture samples, IV and II produced firmer curd (at 40°C for 14 hours)

with the curd strength of 31.23 g and 30.70 g, respectively. However the differences in curd tension, due to changes in incubation temperature and source of culture were not statistically significant.

5.1.4 Synerisis

Synerisis, i.e. the water losing property of curd, reflects the water holding characteristic of curd,and is important to the body, texture and composition of resultant muska (i.e. curd mass retained after the drainage of whey). Since the curd tension values for samples obtained after 12 hours and 14 hours of incubation were not much different, their whey seperation behaviour was studied over a period of 6 hours at the end of every 30 minutes interval. Synerisis data are presented graphically in Fig 5.3.

From Fig 5.3, it is apparent that the maximum quantity of whey was released during the first couple of hours of draining. Whey expulsion was slightly higher from the curd incubated at 40^{o}C for 12 hours. Similarly whey drained from the curd fermented for the duration of 12 hours at 32^{o}C was higher compared to that observed for the curd fermented for 14 hours.

Developed titratable acidity, pH, curd strength, synerisis and flavour characteristics of the curds did not exhibit any

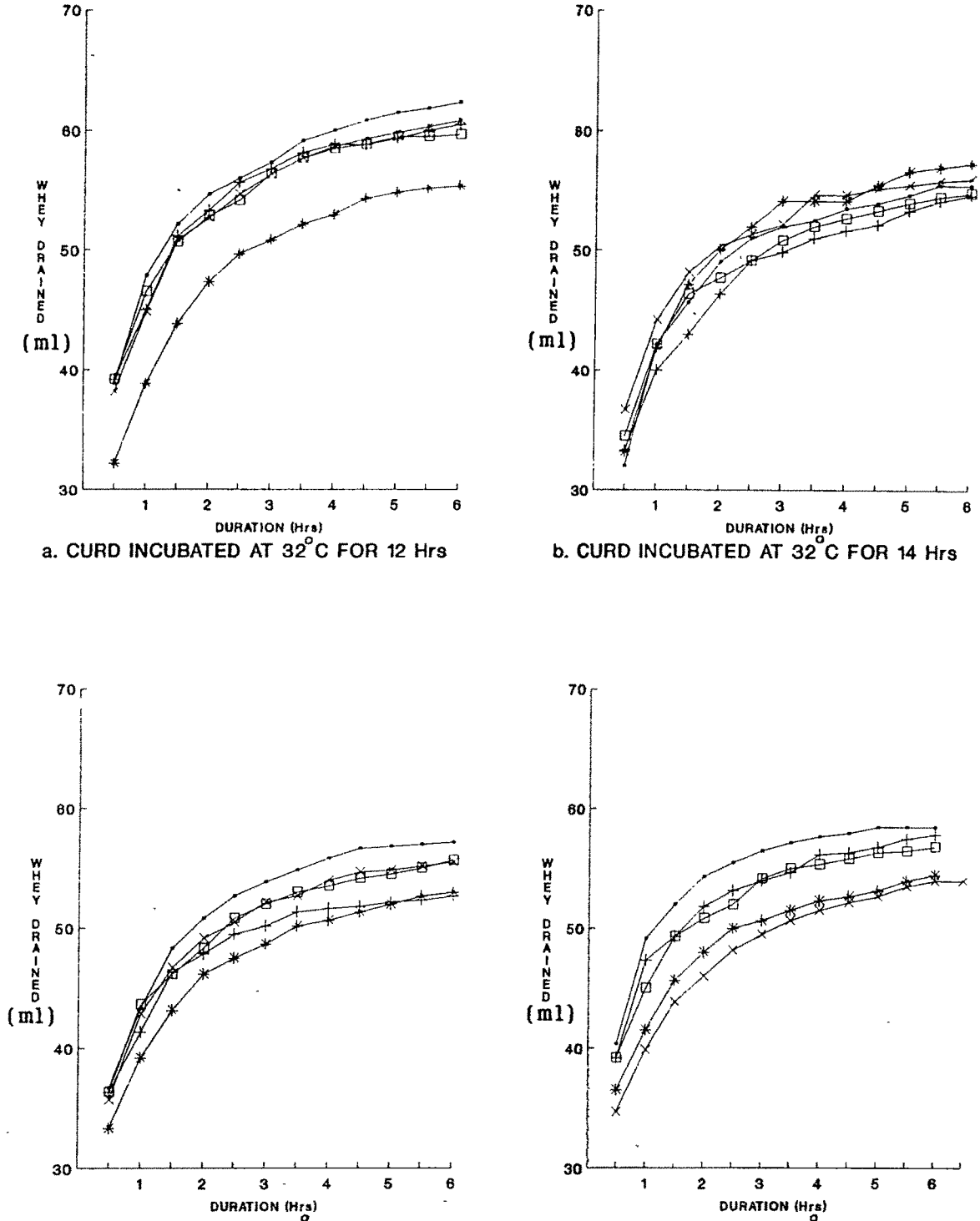


Figure 5.3 : Quantity of whey drained from soycurds incubated at 32°C and 40°C for 12 and 14 hours.

significant differences due to different sources of lactic cultures and temperatures of incubation. However, culture II, which produced somewhat stronger curd, with slightly higher developed titratable acidity at 40°C for 14 hours, was selected as the source of lactic culture with its desirable incubation temperature of 40°C with the duration of 14 hours for further experimental studies.

From results on the soy curd formation studies presented above, it can be observed that the commercial dahi cultures used in soymilk fermentation did not produce the acidity and pH in the ranges observed with dairy milk systems, e.g. 1% l.a. and pH 4.6 (Gehrke and Weiser, 1947 , 1948). This could be possibly due to the lower level of available fermentable sugars in soymilk, which is less than 1 % as against about 4.8-5 % in cow or buffalo milks (De Man *et al.*, 1987). Mital and Steinkraus (1975) demonstrated that an insufficient acid production by lactic acid bacteria was due to an inadequate level of carbohydrate in soymilk.

5.1.5 Effect of adding different fermentable sugar containing ingredients on soycurd forming properties

In order to establish the effect of type and concentration of fermentable sugars on the conversion of soymilk to soycurd,

experiments were undertaken to add sucrose and lactose at concentration levels ranging from 0.045 to 1 g%, using canesugar as a source of sucrose, and RSM (9% TS), whey (acid whey neutralised to pH 7 (Refer Chapter IV page no.4.5) and powdered lactose as sources of lactose.

The results are presented in two sub-sections, concerned with i) their addition singly, and ii) in combination with each other (data detailed in Ap no. 9.5 - 9.7).

5.1.5.1 Addition of different fermentable sugar containing ingredients singly:

Prior to the autoclaving of soymilk, canesugar (0.25, 0.5, 0.75 and 1 g in 100 ml), RSM (1 to 5 % v/v), and powdered lactose (0.25, 0.5, 0.75 and 1 g/100 ml) were added. Addition of whey (obtained by draining lactic fermented curd, and neutralising to pH 7.0 with the addition of calcium hydroxide) prior to autoclaving soymilk caused its precipitation during autoclaving. Therefore neutralised whey was added (2.5 to 10 % v/v) after the autoclaved soymilk was cooled to room temperature before fermentation. Data on the developed titratable acidity, pH and curd strength at the end of 14 hours incubation of the samples at 40^{o}C are presented in Fig 5.4.

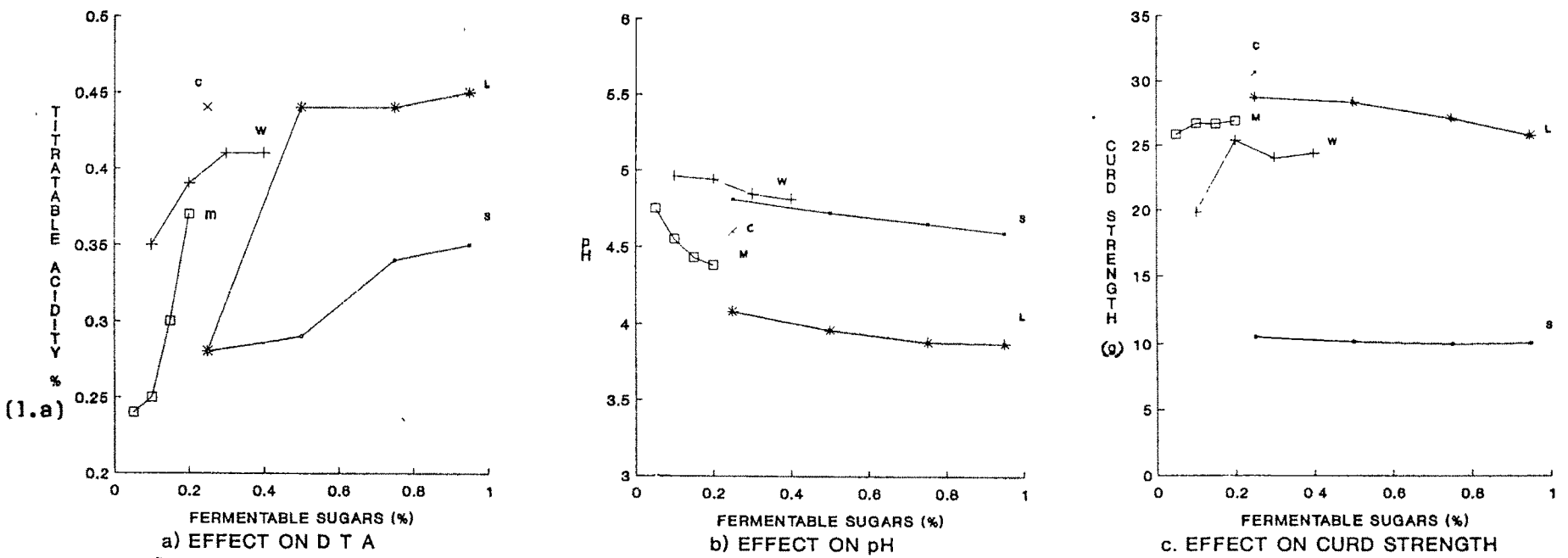


Figure 5.4 Effect of added Sucrose (s), RSM (m), whey (w) and lactose powder (L) on Soycurd forming properties.

C : Controls with 5% RSM.

As indicated in Fig 5.4, the calculated concentration of fermentable sugars ranged from 0.045 to 1 g%. Sucrose addition had the effect of producing lowest developed titratable acidity ranging from 0.24 to 0.37 % l.a. as against DTA of 0.44 % l.a. observed in the case of control containing 0.225 % lactose (added in the form of 5 % v/v added RSM). At the 0.25 g/100 ml level of added sucrose, soymilk curd had a developed titratable acidity of only 0.24 % which rose to 0.37 % l.a. at the sucrose level of 1 g/100 ml. A similar level of lactose containing system resulted in a much higher developed titratable acidity. However, the milk containing 0.25 g/100 ml powdered lactose gave a curd with developed titratable acidity as low as 0.28 % l.a., as was observed for 0.25 g sucrose containing system.

Lactose concentration in the form of added RSM, whey and powdered lactose ranged from 0.045 g to 1 %. In general, higher developed titratable acidity production was associated with a higher lactose level in soymilks. In the case of soymilk containing whey, developed titratable acidity was higher than those obtained with milk containing system. Addition of whey up to the level of 10 ml in soymilk (i.e 0.4 % lactose) produced developed titratable acidity of 0.41 %, which was lower than that of controls with 0.225 % lactose. Even the powdered lactose containing systems (0.25 to 1 %) did not yield DTA much higher

than the DTA attained by the controls. In all the four cases the increasing trend in DTA was observed with the increase in the concentration of fermentable sugars added.

The pH values of curds ranged between 4.81 - 4.08. Among the lactose containing systems powdered lactose, gave curds with pH values lower than that of controls. Whey yielded curds with higher pH compared to the pH values of controls and sucrose containing curds. At similar concentrations, sucrose did not cause any lower pH than that was observed with lactose.

Among the sugar sources used, sucrose yielded weakest curds, with curd strength values of about 10g, which were significantly lower ($p<0.01$) than that of the controls and lactose containing systems. Among the lactose containing systems, those with lactose powder yielded firmer curds compared to whey containing ones. The reduction in curd strength with the increase in lactose was not found to be significant.

It is clear from the above observations that lactose and sucrose, even at 1 % level in soymilk did not appreciably increase the titratable acidity, and curd strength or cause reduction in pH, when compared to soymilk controls. However, in addition to the concentration and the kind of sugars supplemented

in soymilk, the acid production behaviour of lactic cultures vary according to the strains of lactic bacteria used (Angles and Marth, 1971 ; Mital, 1977 ; Pinthong *et al.*, 1980), the total solids present (Chang and Stone, 1990) and the heating temperatures used in its preparation (Angles and Marth, 1971).

5.1.5.2 Effect of combining different fermentable sugar containing ingredients on soycurd forming properties :

Fermentable sugar sources, such as canesugar, whey, milk and lactose, when used alone did not cause significant improvement in DTA, pH and curd strength, compared to soymilk system containing only 5 % RSM. Among the sucrose and lactose containing ingredients used, lactose containing systems resulted in better curd forming properties. Of the lactose containing ingredients, whey containinig systems resulted in weaker curds compared to RSM or lactose. Eventhough, curd strength with RSM was better, the DTA was lower than that obtained with lactose or milk. Therefore, the effect on curd forming properties with following combinations namely a) sucrose (1 %) and lactose containing ingredients at different levels, b) whey 10 % v/v and RSM and powdered lactose, at different levels, and c) RSM at 4 % v/v, with lactose powder at different levels was studied.

Results on curd forming properties of these combined systems are presented in the following sections:

5.1.5.2.1 Combination of soy milk containing sucrose with whey, RSM and lactose powder

Soymilk containing 1 g% of added sucrose was combined with fermentable sugar containing ingredients such as whey (at 2.5, 5.0, 7.5 and 10 ml in 100 ml soymilk), RSM (at 1.0, 2.0, 3.0 and 4 ml in 100 ml soymilk) and powdered lactose (at 0.25, 0.5, 0.75 and 1 g% levels). In terms of incorporation levels, whey addition represented a range of 0.1 % to 0.4 % lactose, milk provided 0.045 % to 0.18 % lactose and powdered lactose provided 0.25 to 1 % lactose. Effect on curd forming properties is graphically presented in Fig 5.5 a-c.

As can be seen from Fig 5.5 a and c, a significant increase in DTA and curd strength was observed with the incorporation of lactose containing ingredients in soymilks containing only sucrose, or only lactose ($p<0.01$). As the lactose concentration increased to 1 g in 100 ml in sucrose containing soymilks, significant increase in DTA from 0.34 to 0.54% was observed. Curd strength values ranged between 35 to 37 g, as against the control values of 28-30 g, (in 5 % RSM soymilks) and 9-10 g in soymilks containing sucrose alone. Soycurds containing sucrose

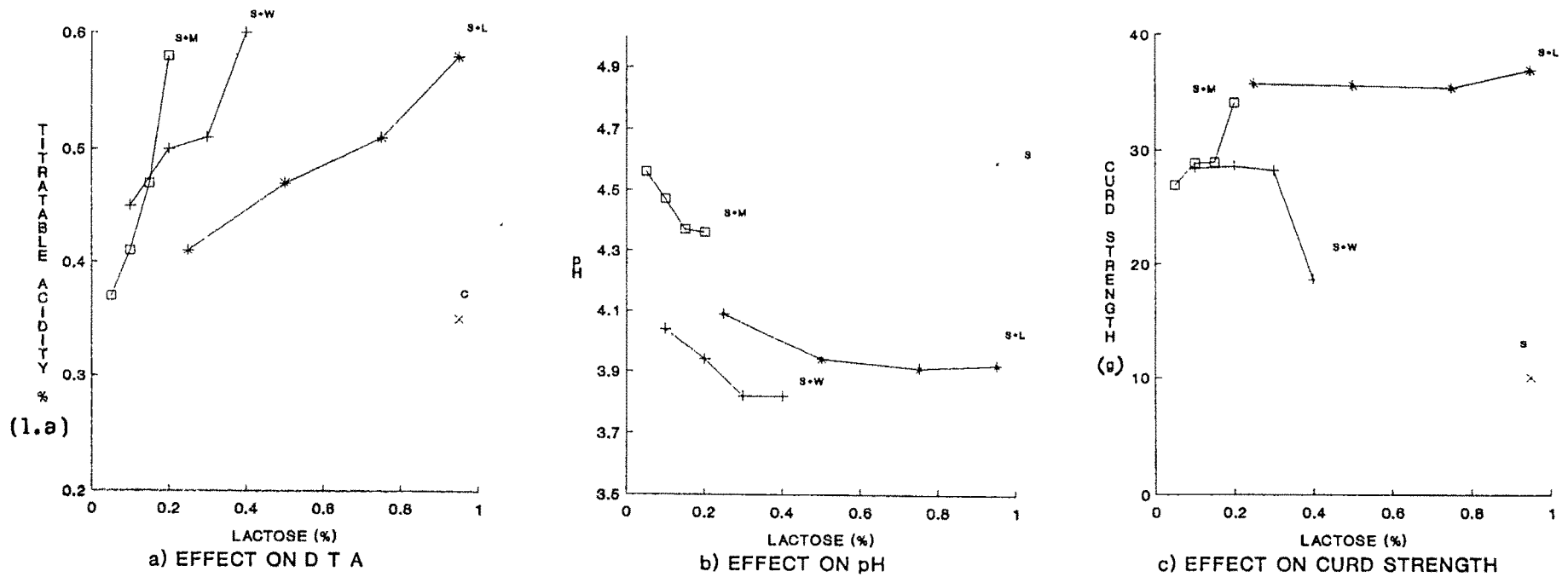


Figure 5.5 Effect oc combining sucrose with whey (s+w), RSM (s+m) or lactose powder (s+L) on Soycurd forming properties.

C: :Controls with 5% RSM, S : Sucrose.

and lactose had lower pH compared to those obtained with only added sucrose (Fig 5.5.b).

When RSM was added as a source of lactose (at 1 ml to 4 ml in 100 ml) to sucrose containing soymilks, an improvement in DTA from 0.37 to the level of 0.54 % l.a. was observed. Values for pH were similar to that of soymilks containing RSM alone. A trend in an increased curd strength was seen with an increasing level of RSM. Curd strength values of 26-32 g were significantly higher ($p<0.01$) compared to 9-10 g for curds containing sucrose alone.

Addition of whey at different levels (2.5 -10 ml in 100 ml soymilk) resulted in the increase in DTA to the maximum level of 0.6 % l.a. Also reduction in pH was higher compared to sucrose combined with RSM or lactose. The increase in the concentration of whey from 7.5 ml in sucrose containing soy milks resulted in significant reduction in curd strength ($p<0.05$) compared to their addition at lower levels.

5.1.5.2.2 Combination of soymilk containing whey with milk and lactose

Combination of whey (added at the level of 10 ml in 100 ml soymilk providing 0.4 % lactose) with powdered lactose at 0.25

to 1g in soy milk resulted in increase in titratable acidity up to the level of 0.8 % l.a. with 1 % lactose, which was significantly higher ($p<0.05$) compared to whey or lactose used alone (Fig 5.6.a). Increase in lactose concentration resulted in significant decrease ($p<0.05$) in curd strength. Values for pH ranged between 3.9-4.1.

Soymilk containing whey (10 ml/100 ml soymilk) combined with RSM at different levels (1-4 % v/v), showed improvement in curd strength to above 30 g which was significantly higher ($p<0.01$) compared to the combination of whey and lactose. The DTA was significantly higher ($p<0.01$) than that of soymilk fortified with RSM alone and was significantly lower than titratable acidity developed with the combination of whey and lactose ($p<0.01$). The pH values were almost similar to that of soymilk fermented with milk alone. Although, an increase in DTA and reduction in pH were observed with the incorporation of lactose in whey containing soymilks, curd strength values decreased in comparison to that of soymilk containing lactose or whey alone. Therefore these combinations were rejected from further studies.

As can be observed from Fig 5.6, unlike powdered lactose, RSM addition in whey containing system showed improvement in DTA, pH reduction and curd strength. The effect on DTA was more

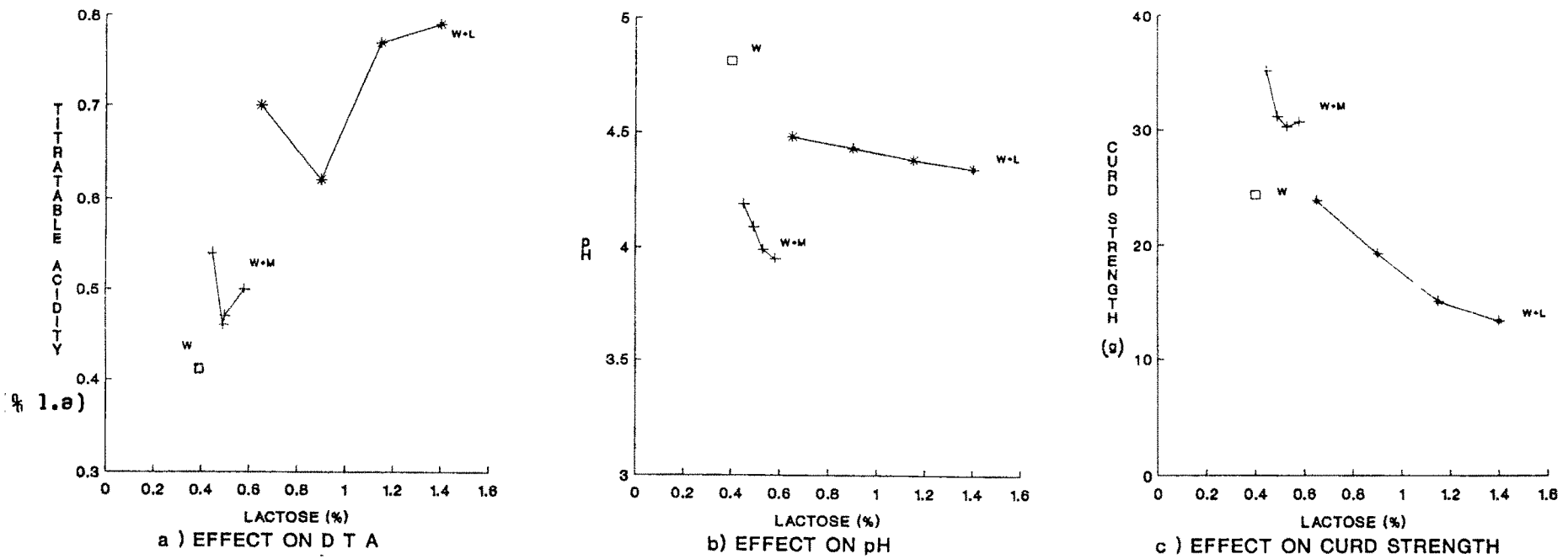


Figure 5.6 : Effect of combining whey (w) with RSM (w+m) or lactose powder (w+L).

pronounced compared to soymilk containing RSM alone, and the effect of curd strength was much higher compared to soymilk, containing whey alone.

5.1.5.2.3 Combination of RSM containing soymilk with lactose

Soymilk containing RSM at the level of 4 % (v/v) was supplemented with powdered lactose at 0.25 % to 1 % level to study the effect on DTA, pH and curd strength (Fig 5.7.a-c). The increase in the concentration of lactose from 0.25 to 1 g powdered lactose in soy milk containing R S M at 4% v/v caused significant increase ($p<0.01$) in developed titratable acidity compared to the DTA of soymilk containing RSM at 4 % alone. Curd strength values ranged between 28 to 33 g, which were higher than the curd tension values obtained with whey and lactose combination.

Differences in the DTA, pH and curd strength for the systems with combined sugars compared with those used singly are graphically presented in Fig 5.8.I, II, III.

Differences due to combining different lactose containing ingredients with sucrose is presented in Fig 5.8.I.

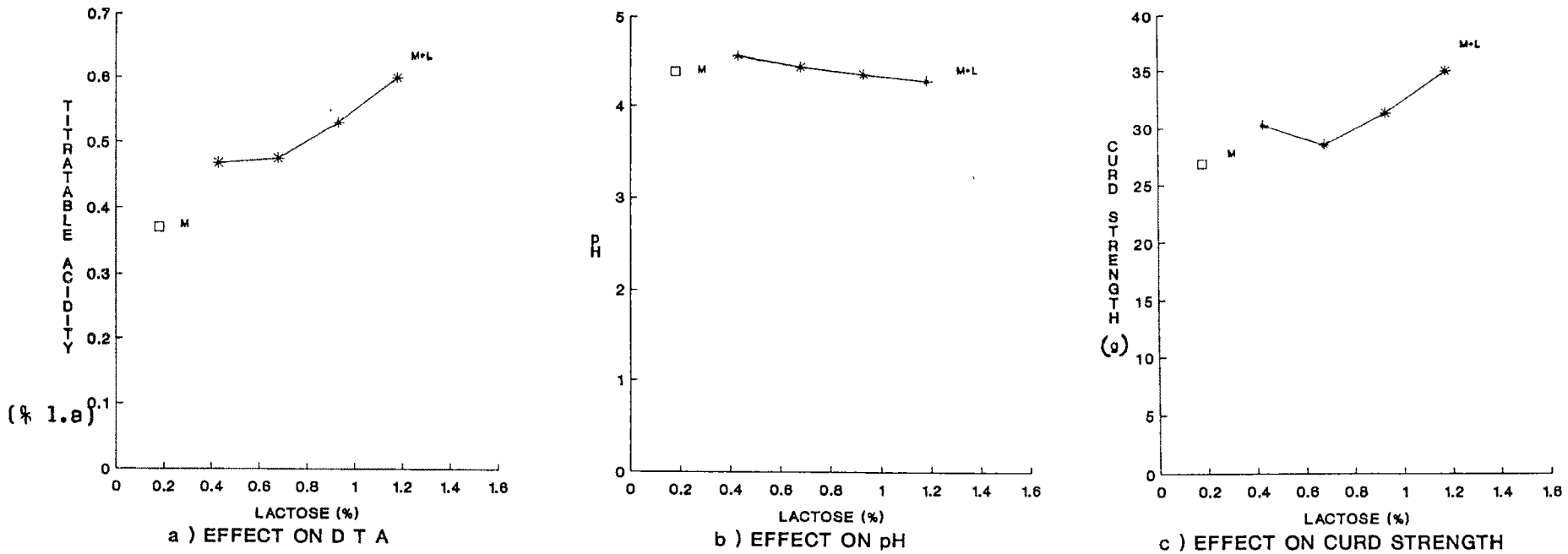


Figure 5.7 Effect of combining RSM (m) with lactose powder (m+L).

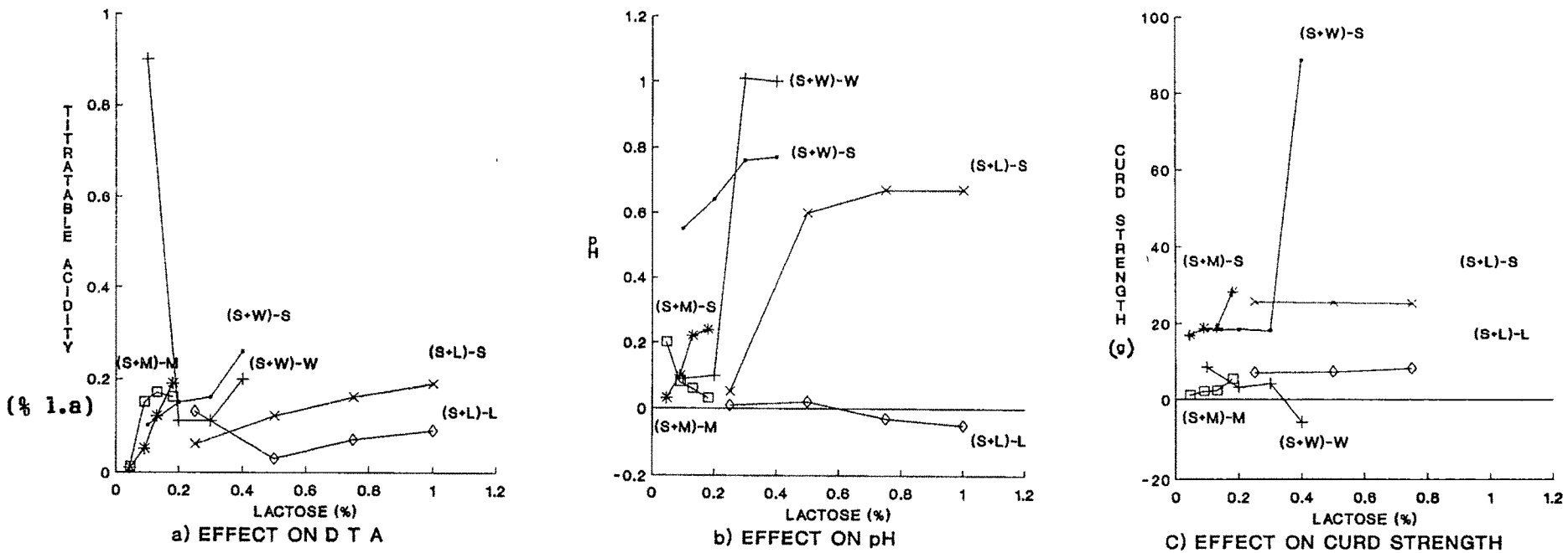


Figure 5.8.1 Differences in DTA, pH and curd strength,
i) Sucrose (s), whey (w), RSM (m), Lactose Powder (L) and their various combinations.

In the sucrose containing systems the effect of combination has been an over all increase in DTA, pH and curd strength. DTA showed maximum increase due to the combination of sucrose with whey when compared to sucrose or whey containing systems alone. The effect of combining sucrose with milk or lactose gave somewhat erratic results showing initial increase followed by decrease in DTA with higher concentrations of milk or lactose.

The effect on pH reduction was more pronounced in the combination of sucrose with whey compared to sucrose with milk or sucrose with lactose. Sucrose with lactose or milk combinations were more effective compared to sucrose, RSM or lactose alone.

Combination of sucrose with whey was not as effective in improving curd strength as the combinations of sucrose with milk or sucrose with lactose. Sucrose containing system when combined with whey showed only slight improvement at lower levels of incorporation. Improvement in curd strength with sucrose milk combination was more effective than when sucrose or milk were used singly.

Differences in the curd forming properties of whey, RSM, lactose and their combinations are presented in Fig 5.8.II.

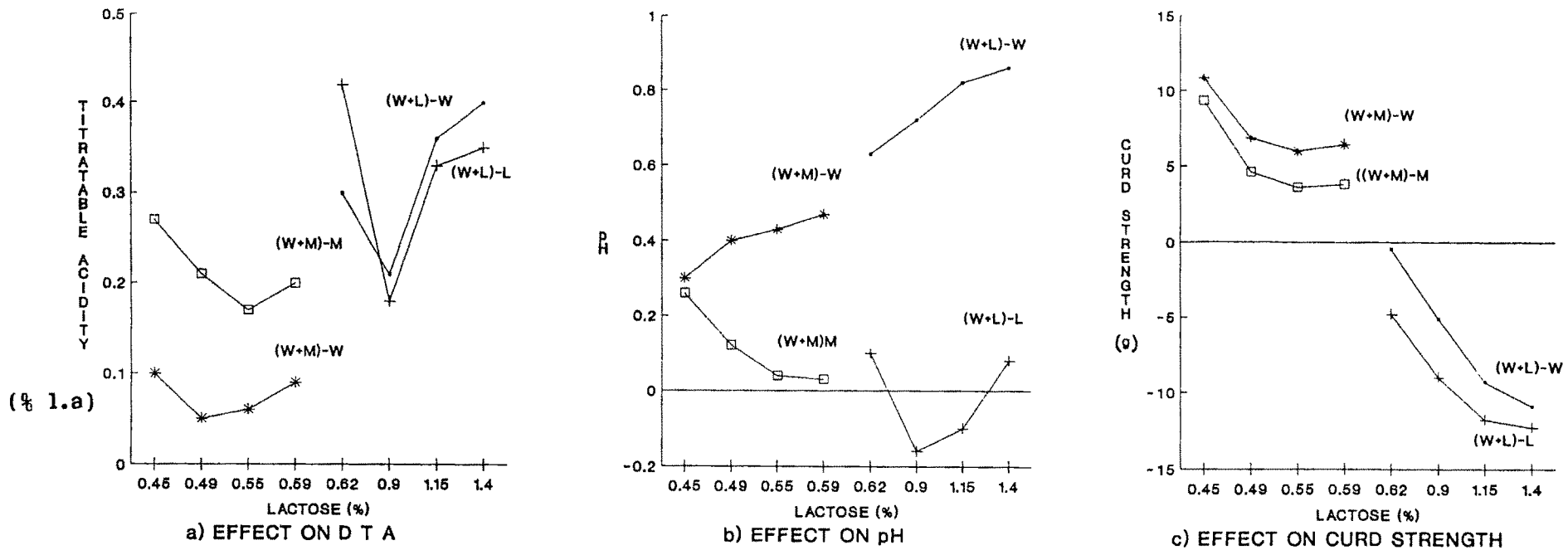


Figure 5.8.2 Differences in DTA, pH and curd strength.
ii) whey (w), RSM (m), Lactose powder (L), whey-RSM (w+m) and whey-lactose powder (w+L).

As it is clear from Figure 5.8.II, whey lactose combinations performed better interms of improving DTA, compared to whey milk combinations, although there was some inconsistency in the improvement at the second level of incorporation. Whey milk combinations was found to be more effective on increasing DTA compared to milk, or whey alone.

Among the whey combinations, whey with lactose showed lower pH compared to whey or lactose alone. Combinations of whey and milk showed pH lower than that of whey alone. The combination of whey and RSM performed better in improving the curd strength, compared to whey lactose combinations.

Differences in the curd forming properties due to RSM, lactose and their combination is shown in Fig 5.8.III.

Combination of RSM and lactose in soymilk resulted in overall improvement in DTA, curd strength. Since the pH values of curds with milk and lactose alone were already lower, the combination of milk and lactose was not more effective in further reducing the pH.

Out of the above six combinations of sugar sources studied (in triplicates), following four combinations of sugar sources gave higher curd strength and DTA, namely : 1. Sucrose and

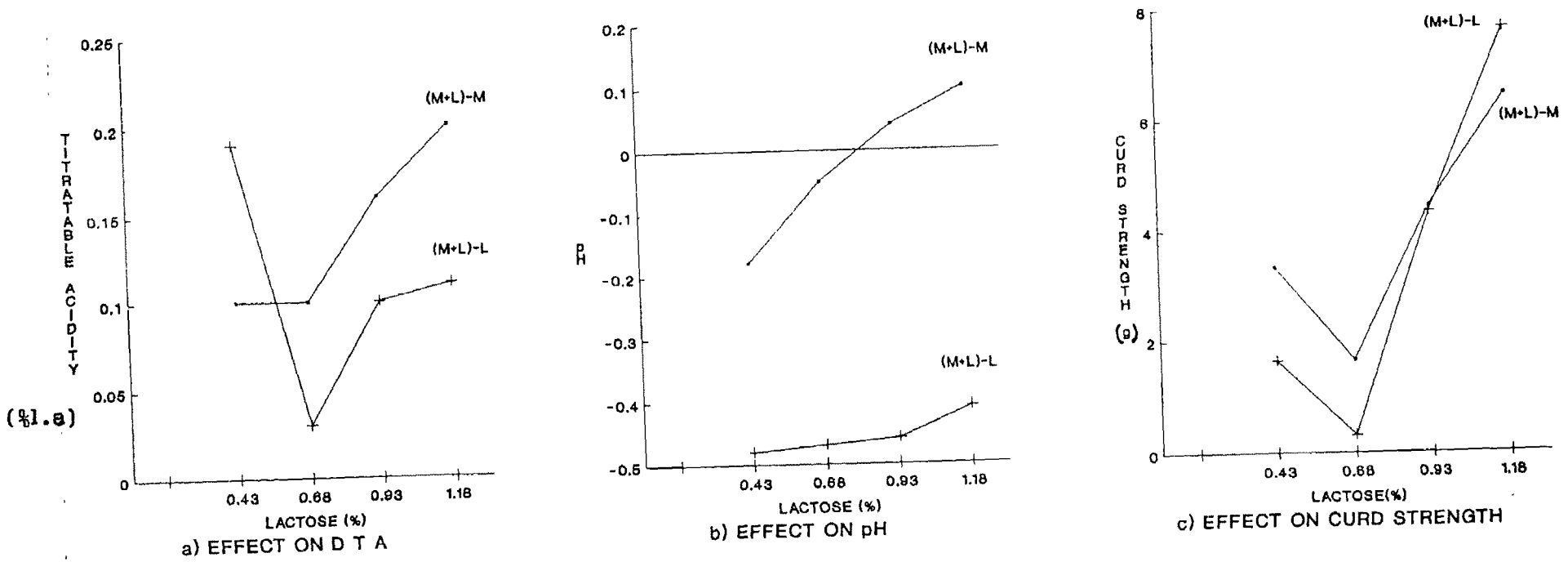


Figure 5.8.3 Difference in DTA, pH and curd strength
iii) RSM (m), Lactose powder (L) and their combinations.

lactose (1 g %), 2. Sucrose (1 g %) and RSM (4 % v/v), 3. Whey (10 % v/v) and RSM (1 % v/v), 4. RSM (4 % v/v/) and lactose (1 g %).

The above four combinations were considered for further six trials inorder to study the curd forming properties. The remaining combinations i.e. whey with sucrose and whey with lactose were discontinued for further studies due to their weaker curd strength. The results of nine trials (i.e. 3 earlier and 6 subsequent) are summarised in Table 5.1.

Table 5.1. Effect of selected combinations of fermentable sugar sources on curd forming properties

Sugar Sources (Conc.in soymilk)		Curd forming properties DTA (%.l.a)	pH	Curd strength (g)
R S M and sucrose (4 % v/v) (1 g %)	Mean	0.53	4.37	34.16
	SD	0.05	0.18	2.96
R S M and whey (4 % v/v) (10 % v/v)	Mean	0.55	4.49	35.14
	SD	0.05	0.26	2.39
R S M and lactose (4 % v/v) (1 g %)	Mean	0.6	4.29	34.75
	SD	0.05	0.18	3.21
Sucrose and Lactose (1 g % each)	Mean	0.6	4.23	36.02
	SD	0.06	0.28	3.76

N.B : Mean values of nine trials.

As can be seen from Table 5.1, these combinations were characterised by the developed titratable acidity in the range of 0.53 to 0.6 % l.a, with the pH of 4.23 to 4.49 and curd strength of 34.16 to 36.02 g. Eventhough, there was no significant difference between these combinations in developing desirable titratable acidity, and pH, two of these combinations viz., sucrose with lactose (1 g % each), representing nonmilk containing system, and whey (10 % v/v with milk 1 % v/v), representing milk containing system, produced curds with higher curd strength 0f 36.02 and 35.14 g respectively. These two combinations were selected for studies on the development of cheese cake.

5.1.6 Treatment of soymilk with bay leaves and lemongrass

Although lactic fermentation results in the improvement of flavour characteristics of soycurd, it was decided to observe whether further flavour improvement would be possible by treating soymilk with bay leaves (*Cinnamomum tamala*) and lemongrass (*Cymbapogan martini*), which are commonly used as natural flavouring agents in various preparations (Greenhalgh, 1979 ; Robbins, 1983). Since the treatment involves heating soymilk with these leaves, their influence on curd forming and sensory properties required to be assessed.

Prior to autoclaving, bay leaves and lemongrass were added at four different levels (0.1, 0.2, 0.3 and 0.4 g %) to soymilks containing sucrose and lactose or whey and RSM. The leaves were removed from the milk by straining through muslin cloth before the lactic culture was added for setting the curd at 40^{o}C for 14 hours.

5.1.6.1 Effect on curd forming properties

The effect of bay leaves and lemongrass treatment on the titratable acidity, pH, and curd strength of two different systems are presented in Table 5.2 and the detailed data is appendixed in Ap.no 9.8 - 9.9.

Soymilk containing sucrose and lactose treated with bay leaves had a developed titratable acidity in curds, ranging from 0.47 to 0.54 % l.a. In the case of soymilk containing whey and RSM, the DTA was between 0.52 to 0.57 %. However, these DTA values were not significantly lower than 0.6 % l.a, for untreated soycurd controls. Similarly, pH and curd strength values were not altered significantly due to the bay leaf treatment.

Sucrose-lactose containing soymilks treated with lemongrass resulted in a slightly lower DTA, with the lowest value of 0.52 % l.a. at 0.3 % level of treatment. In the whey-milk

5.2 Effect of bay leaf and lemon grass on Curd Forming Propertirs of Soy Milks Containing Sucrose and Lactose or whey and Reconstituted Skimmed Milk (RSM)

SOY MILK SYSTEM CONTAINING										
	SUCROSE + LACTOSE (1.0%) (1.0%)					WHEY + RSM (10ml) (1ml)				
Conc. (%)	D T A (%l.a.)	FINAL pH	CURD STRENGTH (g)	MUSKA YIELD (g)	MUSKA T A (%l.a.)	D T A (%l.a.)	FINAL pH	CURD STRENGTH (g)	MUSKA YIELD (g)	MUSKA T A (%l.a.)
BAY LEAF										
0.1	0.54	4.21	35.67	29.11	0.43	0.56	4.62	34.17	32.00	0.47
0.2	0.50	4.14	35.07	30.89	0.45	0.53	4.61	34.43	32.78	0.50
0.3	0.47	4.16	35.60	30.33	0.44	0.52	4.53	33.07	32.11	0.47
0.4	0.51	4.09	34.90	28.78	0.45	0.57	4.37	32.60	31.44	0.47
Average	0.51	4.15	35.31	29.78	0.44	0.55	4.53	33.57	32.08	0.48
LEMON GRASS										
0.1	0.57	4.07	35.16	31.94	0.50	0.59	4.06	34.50	31.22	0.50
0.2	0.57	4.07	34.66	30.74	0.50	0.53	4.39	36.10	31.56	0.50
0.3	0.52	4.09	34.53	31.01	0.47	0.52	4.48	34.20	31.67	0.49
0.4	0.55	4.08	34.16	31.30	0.47	0.49	4.42	36.00	30.33	0.48
Average	0.55	4.08	34.63	31.25	0.49	0.53	4.34	35.20	31.20	0.49
CONTROL										
-	0.60	4.23	36.02	31.44	0.46	0.55	4.49	35.14	30.11	0.49

systems, there was a slight improvement in DTA up to 0.3% level. But these differences were not significant compared to those of controls. Curd strength slightly decreased with increasing lemongrass concentration. The DTA, pH and curd strength values of

curds prepared with lemongrass treatment were, however not significantly different from those of controls.

It was clear from above that autoclaving of soymilk with bay leaf or lemongrass did not affect its curd forming properties. Their effect on improving the flavour attributes was studied next by the conversion of bay leaf/lemongrass treated soymilk curds to cheese cakes, according to the procedure described in Chapter IV (page no 4.4).

The curd obtained from bay leaf/lemongrass treated soymilks was drained for 6 hours to eliminate whey. As already shown in Table 5.2, the yield of muska (the concentrated curd at the end of whey removal), from the untreated soymilk curds were in the range of 28 to 32 g per 100 g of curd. Yield of muska from bay leaf treated sucrose-lactose and whey-RSM containing systems ranged from 28 to 31 g and 31 to 32 g, respectively. With the lemongrass treatment yield of muska was in the range of 30 to 31 g with both the milks.

Treatment of soymilk with bay leaves or lemongrass did not alter the yield characteristics of muska. Titratable acidity of muska was slightly higher in the case of lemongrass treated milk which ranged between 0.47 % - 0.5 % l.a. than the titratable acidity 0.43 - 0.47 % l.a. with bay leaf treated milk

but were not significantly different from that of untreated curds. These results also indicated that the curd forming properties were not affected with bay leaf or lemongrass treatment.

With the above results it can be observed that the treatment of soymilk with bay leaves or lemongrass added in the range of 0.1 to 0.4 % level did not alter the curd forming characteristics in either of the soymilks i.e., soymilk containing sucrose and lactose, or whey and milk.

5.1.6.2 Effect on the sensory properties of cheese cake

Cheese cakes were prepared from soy muska obtained from sucrose-lactose and whey-RSM containing soycurds, by adding to them equal amount of sugar, thoroughly mixing the mass to dissolve the sugar, and working through a sieve (60 BSS mesh) to get a lump-free procuct. The resultant mix was further blended with 33.3 g % whole egg, added as a thickening and coagulating agent. The mass was heated without stirring in a water bath at 70^{o}C for 30 min to promote setting of the cheese cake. The product was cooled to room temperature and was subsequently stored in a refrigerator (10^{o}C - 4^{o}C) before sensory evaluation.

Sensory evaluation of the product was done interms of its colour & appearance, body & texture , flavour and overall acceptability, using a 5 point hedonic scale (refer Chapter IV page 4.10). Mean scores of bay leaves and lemongrass treated products for different sensory attributes are presented in Table 5.3 and the data subjected for statistical analysis is appendixed in Ap.no. 9.10.

Table 5.3 Sensory properties of the Cheesecakes prepared from Bay leaf and Lemon grass treated soy milk system

Sensory Attributes	Sensory Scores of Chees Cakes from Soy Milk Containing										
	Sucrose and Lactose										Whey and milk
	Treated with										Treated with
	BAY LEAVES (g/100 ml)					LEMON GRASS (g/100 ml)					BAY LEAVES (g/100 ml)
	0.1	0.2	0.3	0.4	Avg.	0.1	0.2	0.3	0.4	Avg.	Con.	0.1	0.2	0.3	0.4	Avg.
COLOUR & APPEARANCE	3.8	3.7	3.5	3.7	3.6	3.9	4.1	4.1	4.0	4.0	3.8	3.7	3.8	3.8	3.8	3.7
TEXTURE	3.7	3.6	3.3	3.7	3.5	3.8	4.0	4.0	3.9	3.9	3.7	3.7	3.6	3.5	3.7	3.6
FLAVOUR	2.7	2.8	2.8	2.8	2.7	3.5	3.5	3.6	3.7	3.5	3.0	3.3	3.2	3.4	3.1	3.2
O.A.	2.8	3.0	2.8	2.9	2.8	3.3	3.5	3.5	3.6	3.4	3.0	3.3	3.1	3.3	3.2	3.2

Sensory Attributes	Whey and milk									
	Treated with									
	LEMON GRASS (g/100 ml)									
	0.1	0.2	0.3	0.4	Avg.	Con.				
COLOUR & APPEARANCE	3.7	3.8	3.8	3.8	3.7	3.8				
TEXTURE	3.7	3.6	3.5	3.6	3.6	3.5				
FLAVOUR	3.3	3.7	3.5	3.5	3.5	3.0				
O.A.	3.1	3.2	3.2	3.2	3.1	2.7				

Con. Control
Avg. average score considering all the four levels together

Level of adding bay leaf or lemongrass did not significantly influence on flavour characteristics of cheese

cake. However, in sucrose and lactose containing soymilk systems, lemongrass found to result in product with better scores for flavour ranging from 3.3 to 3.6 as against the bay leaf treated products, which obtained slightly lower flavour scores of 2.7 to 3.0.

Cheese cakes prepared with the soymilks having sucrose-lactose and whey-RSM did not exhibit significant difference interms of their sensory characteristics at any level of bay leaf or lemongrass treatment. The mean scores for the overall acceptability of the products did not exceed 3.6 indicating that the products were only "liked slightly". The common criticism was regarding the "eggy" off flavour of the product rather than "beany flavour" of soybean.

5.2 Effect of various additives and treatments on product quality

The cheese cakes prepared with egg as a thickening agent has a disadvantage of leaving residual egg flavour in the product as well as the product prepared with egg is not accepted by those who consider it as a non-vegetarian commodity. In order to improve the product characteristics in this regard, study was planned to replace egg completely in the preparation of cheese cake with other thickening agents. Other modifications attempted

in the improvement of product characteristics include, incorporation of natural and artificial flavouring and colouring agents. Results of these studies are presented in this section under the following sub-sections :

5.2.1. Effect of egg concentration and setting temperature
5.2.2. Replacement of egg with other thickening agents
5.2.3. Addition of colouring and flavouring agents
5.2.4. Standardised process for the preparation of cheese cake

5.2.1 Effect of egg concentration and setting temperature on the quality of cheese cake

The "egg" flavour criticism in the cheese cakes might possibly be due to the addition of egg at 33.3 % level to the muska. In order to study the effect of reduced egg levels on flavour as well as body and texture of cheese cake, whole egg was incorporated in the soymilk based muskas at 25, 30, 35, 40, 45 and 50 g per 100 g muska, representing 20, 23, 26, 28.5, 31 and 33.3 g % egg levels, respectively. The effect due to various levels of egg addition in the cheese cake was studied in terms of gel strength for body and texture charateristics,and organoleptic evaluation for sensory characteristics.

Physico-chemical properties such as Titratable Acidity (TA), pH and gel strength of cheese cake prepared with the different proportion of egg added is presented graphically in Fig 5.9.a-c, and data detailed in Ap.no. 9.11 and 9.12.

Increase in the proportion of egg added to the sugar-muska mix caused a slight reduction in TA. The TA of the sugar-muska-egg mix ranged from 0.73 to 0.71 % l.a in the case of muska prepared from sucrose-lactose-curd systems and was not found to be significantly different from that of the TA of sugar-muska mix which ranged between 0.7-0.75 % l.a prepared with the soy-curd system containing whey-milk.

The pH values of the mix with the incorporation of egg at increasing levels showed slight increase in pH which ranged between 4.6-4.8 with the muska prepared from curd system containing sucrose and lactose. Eventhough, the pH values of the sugar-muska mix prepared with the muska obtained from whey-milk systems showed slightly lower values for pH ranging between 4.5-4.7, the differences were found to be not significant.

The gel strength, as an indicator of the body and textural attribute of the cheese cake, was measured using curd tension meter as described in Chapter IV page no. 4.11 The increasing gel strength values of 83-119 g with sucrose-lactose

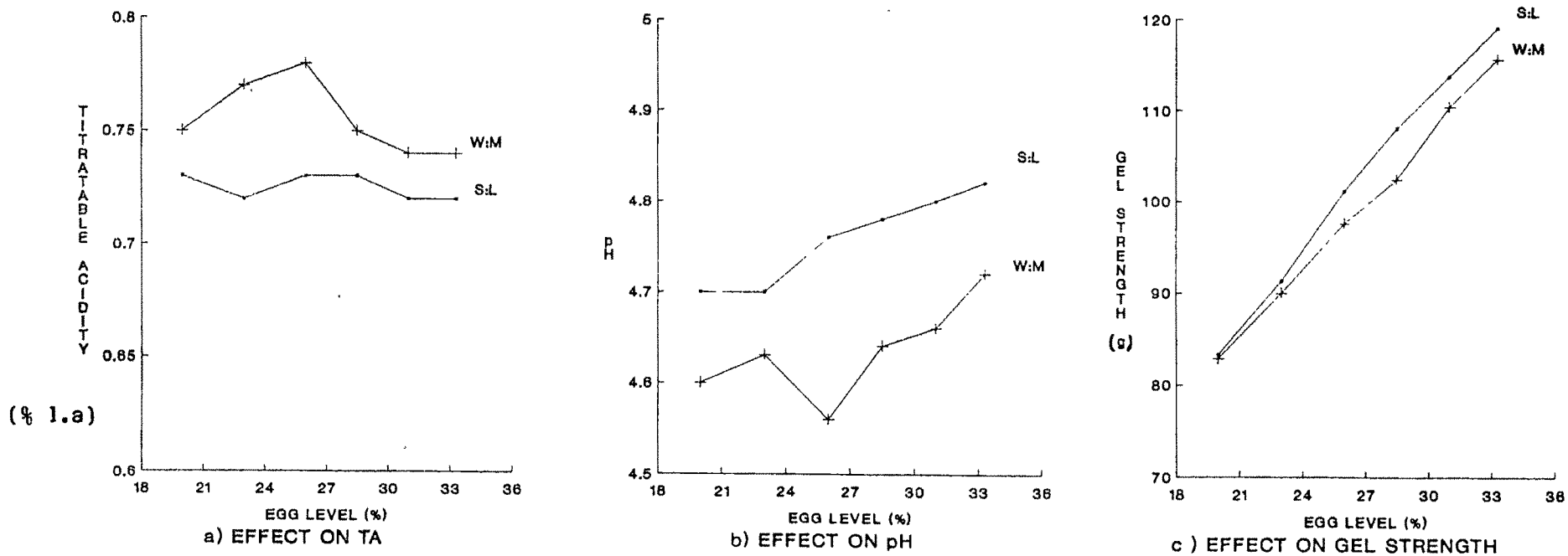


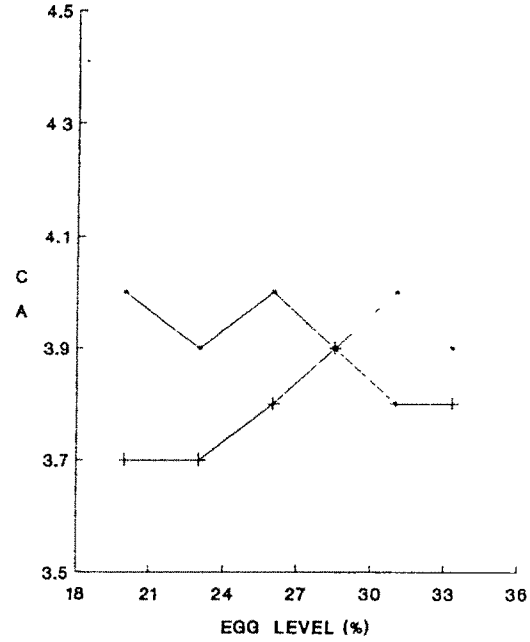
Figure 5.9 Effect due to the addition of egg on TA, pH and gel strength characteristics of cheese cake Prepared with sucrose : Lactose (S:L) and whey:RSM (W:M) system.

systems and 82-115 g with whey-RSM systems, showed a significant positive correlation ($p< 0.01$) with increasing concentration of egg added in the range of 20 to 33.3%. Although, the whey-RSM system values for gel strength were slightly lower (82-115 g) than those of sucrose-lactose (83-119), these differences were not statistically significant.

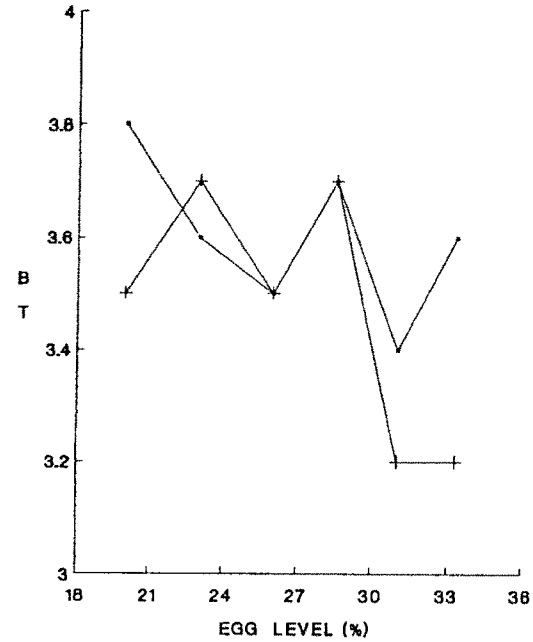
Results of sensory evaluation of the cheese cake prepared with muskas obtained from sucrose-lactose and whey-milk systems with different proportion of egg and at the setting temperature of 70^{o}C are presented in Fig 5.10. a-d, (detailed data in Ap.no. 9.13 and 9.14.

Mean scores for colour and appearance did not show any change due to the alteration of egg level in both sucrose-lactose and whey-milk muskas. The mean scores indicated that the colour and appearance characteristics were in the "desirable" level with the mean scores above 3.5.

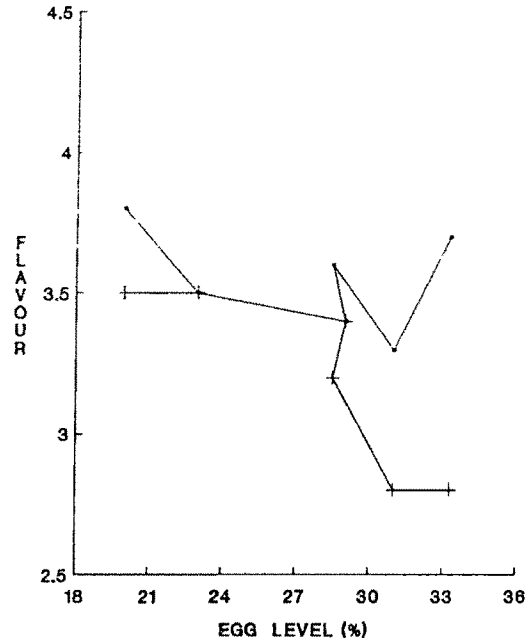
The scores for textural characteristics of the products were in the "desirable" level of acceptability with mean scores ranging from 3.2 to 3.8. Eventhough the gel strength measurement showed increasing firmness of cheese cakes, sensory data on textural characteristics did not indicate any significant increase in the preference. However, the whey-milk systems showed



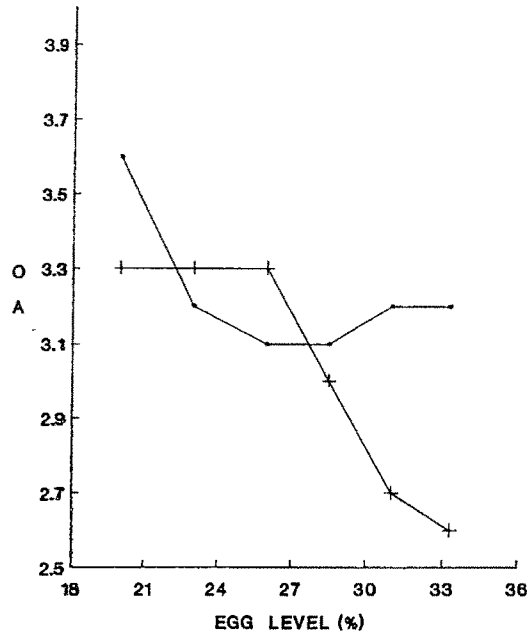
a. EFFECT ON COLOUR AND APPEARANCE



b. EFFECT ON BODY AND TEXTURE



c. EFFECT ON FLAVOUR



d. EFFECT ON OVERALL ACCEPTABILITY

Figure 5.10 : Sensory evaluation of cheese cake prepared with muskas obtained from sucrose-lactose and whey-RSM system with different proportion of egg set at 70°C.

Systems used — sucrose:lactose — whey:milk

significant decrease ($p < 0.001$) in the preference for texture, with the addition of egg above 26.0 %. The product was criticised as too tough.

The mean scores for flavour acceptability indicated no positive or negative trend in the case of products made with sucrose-lactose containing soy-curd system. Whereas, whey-milk containing soy-muska showed a significant decrease in the flavour scores with an increase in the proportion of egg above 31.0 % .

Overall acceptability scores of products showed lowering trend in acceptability with the increasing proportion of egg in both muskas. Overall scores of sucrose-lactose muska products did not exceed above 3.6 and were not below 3.1, indicating that they are in the desirable level of acceptability. Muskas obtained from whey-milk system showed a slightly lower scores for overall acceptability, ranging from 2.6 to 3.3 on the 5 point hedonic scale.

Above results indicate that the egg levels influenced the product characteristics due to their gelling or coagulation properties. The heating treatment given for setting the cheese cake is also likely to affect the resultant textural properties of cheese cakes. Therefore it was decided to study the

effect of setting temperatures ranging from 60 to 80°C (i.e., 60, 65, 75 and 80°C) on cheese cakes with different proportions of egg using the soy-muska obtained from sucrose-lactose containing soymilks.

The results on gel strength and sensory evaluation of these products are presented in Fig 5.11 and 5.12 (a-d) and the data detailed in Ap. no. 9.11 and 9.13.

As can be seen from Fig 5.11, gel strength increased along with increasing setting temperature. Cheese cake prepared at 60°C for 30 minutes resulted in weaker products, with the gel strength values of 43-57 g, particularly in the range of 28.5 to 33.3 % egg levels. Heating at 65°C for 30 minutes did not show any significant improvement on gel strength compared to those treated at 60°C. The lowering of gel strength values of cheese cakes prepared by setting at 60 and 65°C, was associated with the increasing concentration of egg. The maximum gel strength of 59 g was achieved with 20 % egg whereas the increased concentration of egg to 33.3 % resulted in the minimum gel strength value of 43 g. Therefore the heating temperatures of 60 and 65°C for 30 minutes were found to be unsatisfactory for the body and texture properties of the final product.

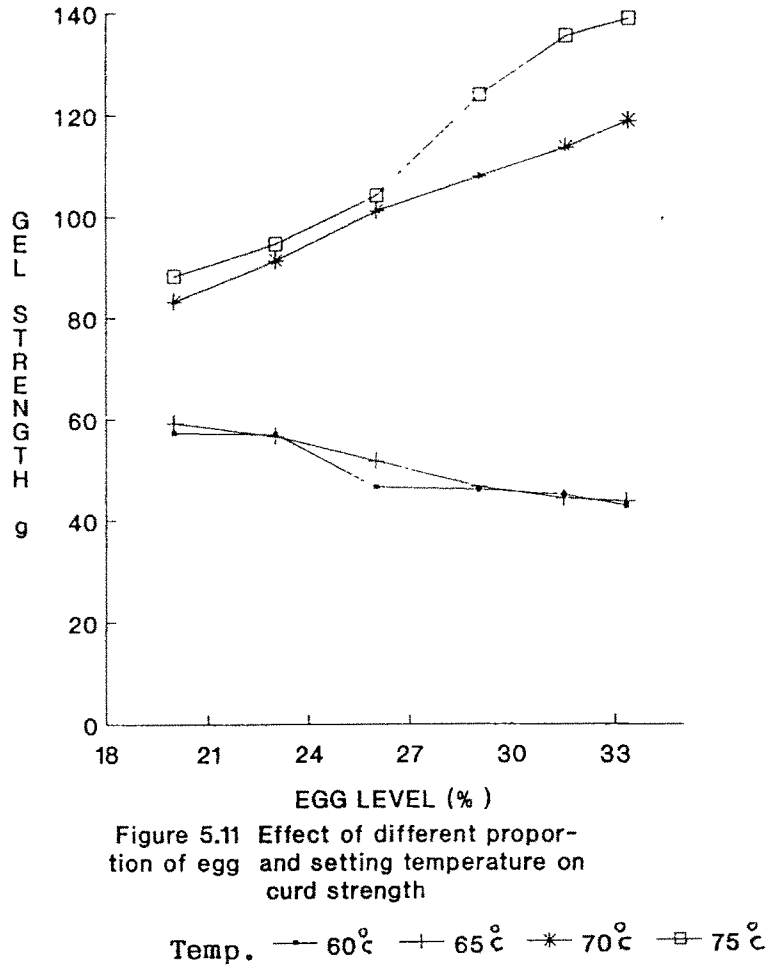
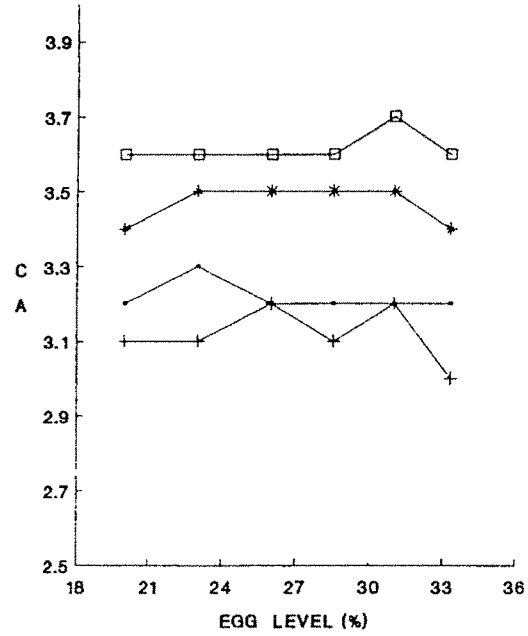
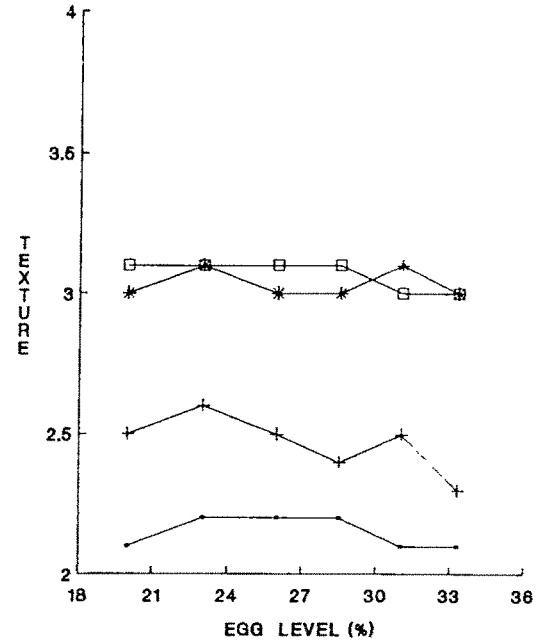


Figure 5.11 Effect of different proportion of egg and setting temperature on curd strength

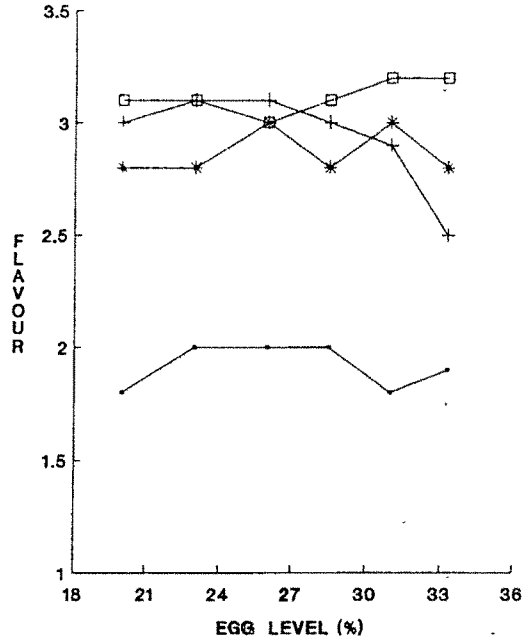
Textural scores obtained upon sensory evaluation for these products prepared at 60 and 65°C also indicated weaker body and texture attributes of cheese cakes (Fig - 5.12. b). The mean scores for the products heated at 60°C was not above 2.2. The products prepared at 65°C obtained significantly lower ($p<0.001$) scores of 2.3 to 2.6, against the mean scores of 3.4-3.8 of the control products heated at 70°C.



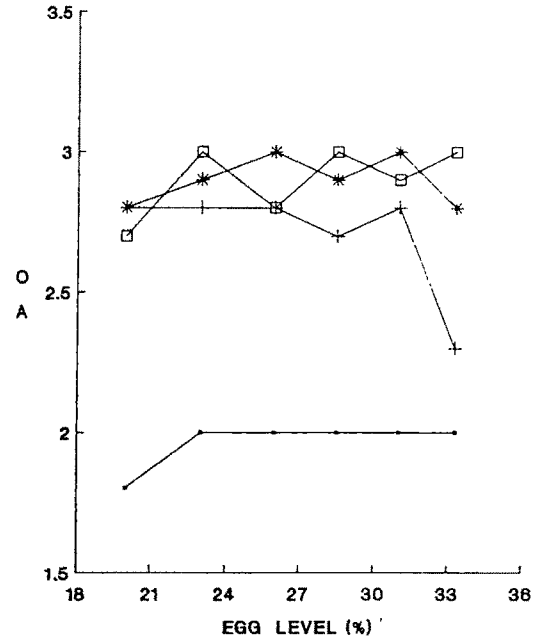
a. EFFECT ON COLOUR AND APPEARANCE



b. EFFECT ON BODY AND TEXTURE



c. EFFECT ON FLAVOUR



d. EFFECT ON OVER ALL ACCEPTABILITY

Figure 5.12 : Sensory evaluation of cheese cake prepared with different proportion of egg and setting temperatures.

Setting Temp. — 60°c — 65°c — 75°c — 80°c

In addition to weaker body and texture scores, flavour scores for the 60 and 65°C were also significantly lower ($p < 0.001$), in the range of 1.8-2.0, compared to 3.3-3.8 for controls. These setting temperatures resulted in a somewhat undercooked product.

The overall unsatisfactory result at 60°C and 65°C setting temperatures was also evident from significantly lower ($p < 0.001$) overall acceptability scores of 1.8 to 2.0 (for 60°C), and 2.3 to 2.8 (for 65°C), as against 3.4 to 3.8 for controls. Although the scores for 65°C treatment were somewhat higher than those for 60°C in case of body and texture and overall acceptability, difference was not found to be statistically significant.

Increasing the setting temperatures to 75°C caused significant ($p<0.01$) increase in gel strength compared to cheese cakes prepared at 60 and 65°C . The gel strength values for the products heated at 75°C ranged between 88 to 139 g showing an increase in gel strength with the increasing concentration of egg. Further increase in the setting temperature to 80°C resulted in very tough gels, The gel strength of samples with this setting temperature could not be measured as the knife could not smoothly cut through the gel and lifted the whole coagulated mass from the containers as the counter weight was increased.

The cheese cake obtained with the setting temperatures of 75°C and 80°C showed poor quality characteristics such as shrinkage and wheying off.

Sensory evaluation of the 75°C and 80°C products showed significant improvement ($p < 0.001$) in terms of body-texture, compared to products obtained at 60°C and 65°C setting temperatures. The mean scores for texture ranged between 3-3.1 for 75°C treatment, and were not found to be significantly different from the scores of the products obtained at 80°C. The increase in the proportion of egg even at these temperatures did not indicate any significant change on the textural characteristics of the products upon sensory evaluation. The products obtained with 75°C and 80°C heat treatment were criticised as very "coarse" and "granular".

Compared to the 70°C treated controls, the flavour scores for 75°C products were significantly lower ($p<0.001$). Colour and appearance of these products were also found to be lower compared to controls but were not significantly different. The overall acceptability scores of the products prepared at the setting temperature of 75 and 80°C did not indicate any consistent pattern of preference in terms of their egg level. The overall acceptability of these products were not significantly

different and the scores ranged between 2.7 - 3.0 compared to controls with the scores of 3.1-3.6.

It is clear from the above results, that the heating temperatures of 60 and 65^{o}C for 30 minutes were insufficient to cause proper setting of cheesecake and the higher temperatures such as 75 and 80^{o}C resulted in very tough gel with poor textural characteristics compared to controls. Therefore, setting temperatures of 60, 65,70 and 80^{o}C were rejected. The proportion of egg added to the sugar-muska mix at 70^{o}C did not show any significant change of textural characteristics upon sensory evaluation. Therefore, heating temperature of 70^{o}C with minimum quantity of egg at the level of 20 g % was considered to be suitable.

With the above modifications,cheese cake was prepared from sucrose-lactose soymilks treated with bay leaves and lemongrass at 0.1 g % level. Products were subjected for sensory evaluation to find out whether the flavouring enhancers such as lemongrass and bay leaves used have any effect on the modification of flavour properties after the "egg" type flavour was reduced by lowering the concentration of egg from 33.3 g % to 20 g % level. The results are presented in Table 5.4.

Table 5.4 Sensory properties of cheese cakes prepared with bay leaves and lemon grass treatment

Cheese cakes	Sensory characteristics			
	Colour & Appearance	Body & Texture	Flavour	Overall Acceptability
Bay leaf	3.8	4.1	4.2	4.0
Lemongrass	4.0	3.8	3.7	3.7
Controls	4.0	3.8	3.8	3.8

Among the two treatments bay leaf treated products showed slight improvement up to the level of 4.2 for flavour scores and the lemongrass treated products had slightly lower scores of 3.7 and were found to be not significantly different from that of controls.

The overall acceptability scores ranged between 3 - 4 with bay leaf treatment and 3.0-3.7 with lemongrass treatment against the controls with the scores of 3.2-3.6. These results indicated that there were still scope for a considerable improvement in the product characteristics.

5.2.2 Replacement of Egg with Other Additives/Thickening Agents

Addition of egg as a coagulant to the soy-muska for the preparation of cheese cake yielded a product with satisfactory

scores for overall acceptability. In the Indian context, however, egg, being a non vegetarian item is not acceptable by many. Therefore, suitable thickening/coagulating agents were examined for substituting egg as a texture modifier for cheese cake.

In a preliminary study different additives such as corn starch, pectin and gelatin, which are commonly used as thickeners in various custard type products, and other ingredients such as bengalgram, greengram, blackgram, rice, potato and wheat were added during the preparation of cheese cake, starting with sucrose-lactose containing soymilk systems.

Additives such as corn starch, gelatin and pectin were added at 0.1 to 0.4 % level to the sugar-muska mix before the final heat treatment for setting the cheese cake. Pectin was also added before autoclaving the soymilk. As detailed in Chapter IV Page no.4.7, bengalgram, blackgram and greengram were added for cheesecake preparations in several ways. Pastes were prepared by mixing ground flour with water or by wet grinding pre-soaked pulses. These were added to the muska before final heat setting stage. The pulses were also wet ground with soy bean in the milk preparation stage. The pulse preparations were also combined with pectin. The level of addition ranged from 20-30 % in 100 g of soybeans. Pastes prepared after boiling soaked and wet ground rice and wheat, and mashed boiled

potatoes were added to the sugar-muska mix before the final heat treatment of 70^{o}C for 30 minutes for setting the cheese cake.

Data on the characteristics of the final product obtained with the addition of thickening/coagulating agents are summarised in Table 5.5.

As indicated in Table 5.5 (Item no. 1, 2, & 3) the addition of corn starch gelatin and, pectin resulted in unsatisfactory product with the common characteristics of being "sticky". Although unpleasant egg flavour was not present, in its absence objectionable beany flavour was felt.

The textural properties of the cheese cake prepared with bengalgram, blackgram and greengram from ground flour and soaked pulses were slightly better than those prepared with pectin. But, these were found to be weaker compared to the cheese cakes developed with egg. The characteristic flavours associated with these pulses was considered unpleasant, making the products unacceptable. These unpleasant flavour attributes were also present in products containing pastes prepared from the soaked pulses, due to which these products were also considered unacceptable.

Table 5.5 Effect of thickening agents on the product characteristics

S No	Thickening Agents added, to prior to setting at 70°C for 30 min	Levels (g %)	Observation of Products
1	Corn starch, added to muska	5 - 10	Sticky, viscous, unacceptable
2	Gelatin, added to muska	0.1 - 0.5	Sticky, lumpy, acidic, off-flavour Unacceptable
3	Pectin, added to muska	0.1 - 0.5	Sticky, acidic, unacceptable unacceptable
4	Thickened slurries, made from pulse flours of Bengalgram, Greengram, Blackgram	20 - 30	Sticky, off-flavour of pulses unacceptable
5	Thickened slurries by wet grinding soaked pulses of Bengalgram, Greengram, Blackgram	20 - 30	Sticky, off-flavour of pulses unacceptable
6	Rice, pre-soaked, ground, boiled and added to muska	50	Acceptable product with granuar texture, perceptible flavour of rice
7	Wheat, pre-soaked, ground, boiled and added to muska	50	Acceptable flavour, slightly weaker consistency
8	Potato, boiled, deskinned, mashed and added to muska	50	Acceptable product with granuar texture
9	Pulse-paste + pectin (0.1-0.4%) added to muska	20 - 30	Textural improvement, off-flavour characteristics ; unacceptable
10	Pectin added to soy milk before autoclaving	0.1 - 0.4	Better than adding to the mix in terms of texture : sticky, acidic and unacceptable
11	Soaked Bengal gram, Green gram and Black gram wet ground with soy bean during milk preparation	10 - 20	Sticky, smooth, off-flavour of pulses unacceptable

On the other hand, the addition of pastes prepared from presoaked and boiled rice and wheat to the muska mix resulted in products somewhat similar to the cheese cake prepared with egg. The products were however, criticised to be slightly granular compared to the egg based products. Potato paste prepared from boiled and deskinned potatoes resulted in products with acceptable sensory characteristics.

A combination of pectin at 0.1 - 0.4 g % level with the pulse pastes was also tried before the final heat treatment for setting the cheese cakes. This resulted in a product with improved textural characteristics compared to the product prepared without pectin, however the products were considered to be unacceptable due to off flavour of pulses. The off-flavour was more objectionable when the proportion of pulse in the mix was increased above 26 %.

Addition of pectin (dissolved in boiling water) at 0.1, 0.2, 0.3 and 0.4 g % level to soymilk (Item 10, Table 5.5) before autoclaving, showed slight improvement in textural characteristics compared to the products prepared by adding pectin directly to the muska mix before setting by heating. However, other sensory attributes such as colour, flavour, and overall acceptability did not improve and was rejected as an

unacceptable product. The residual beany-flavour could not also be masked.

Addition of soaked (8 hours) pulses such as bengalgram, greengram or blackgram at 10 - 20 % level and wet grinding with soybean in the preparation of soy:pulse milk before lactic fermentation, did not show any improvement on the overall acceptability of the products. The resultant product had similar unpleasant flavour characteristics as observed with the products prepared with the addition of pulse paste to the muska mix. In this preliminary study with several ingredients for the preparation of cheese cake without adding egg, only rice, wheat and potato showed promise as additives. The resultant products were found to resemble more closely to those prepared with egg. However the cheese cakes prepared with rice, wheat and potato were slightly "granular" and "sticky" along with unpleasant flavour characteristics of substituted ingredients.

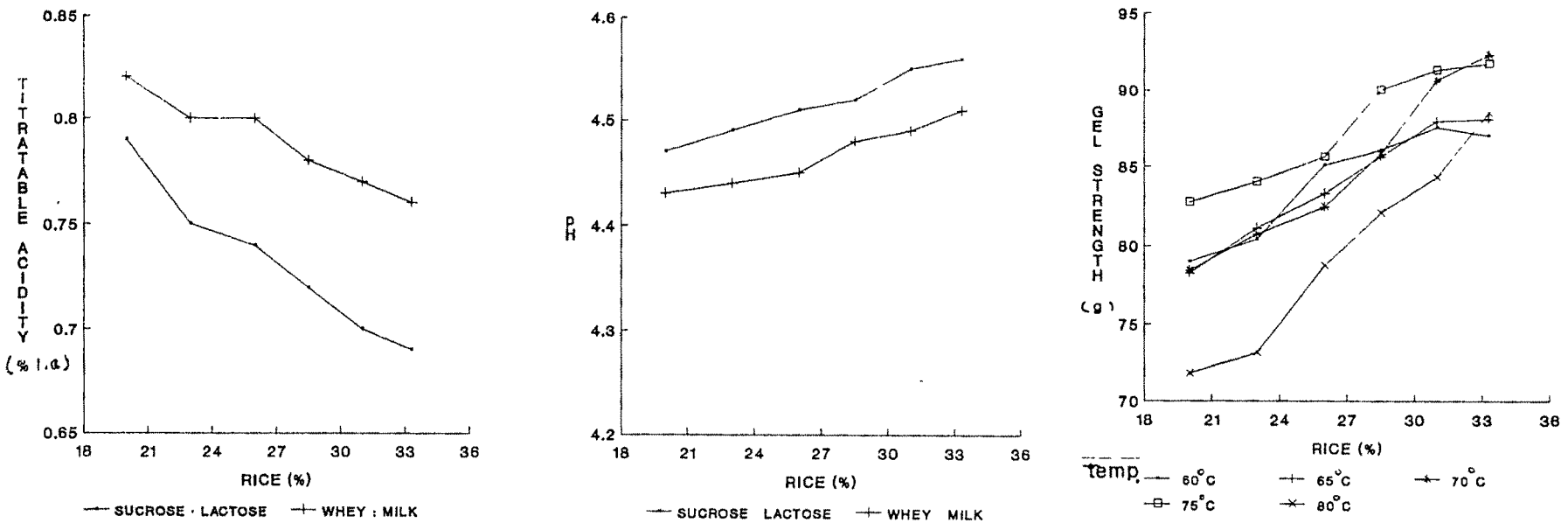
Therefore further studies were undertaken to determine whether with an appropriate level of adding these ingredients and by choosing a suitable setting temperature the flavour and textural characteristics of the cheese cakes could be further improved. The effect of rice, wheat and potato at levels ranging from 20-33.3 g % to the mix heated to 60, 65, 70, 75 and 80^{o}C for 30 minutes was studied in terms of TA, pH, gel strength

and organoleptic scores. Initial trials on setting temperature with different proportion of rice, wheat and potato was carried out with the muska obtained from sucrose-lactose systems. The setting temperature which gave the desirable results with sucrose-lactose containing systems was also used in the muskas obtained from whey-RSM containing systems.

5.2.2.1 Optimisation of concentration level and setting temperature for rice

The effect of rice addition on TA and pH of cheese cake mix is shown in Fig 5.13.a-c (detailed data in Ap.no. 9.11 and 9.12). Increasing the concentration levels of rice paste caused a reduction in TA. The TA of the sugar-muska mix with rice ranged between 0.69-0.79 % l.a. compared to 0.71-0.73 % l.a. with the egg incorporation. The pH values were slightly lower compared to egg-muska mix which ranged between 4.47-4.56.

The gel strength values of sugar-muska mix containing rice showed a significant positive correlation ($p<0.01$) with the increasing proportion of rice in the range of 20 -33.3 % (Fig 13.c). Similarly, increasing setting temperature in the range of 60-75^{o}C showed increasing effect on the gel strength from 78g - 87g to 82g - 91g in cheese cakes containing rice at all levels.



a. EFFECT OF RICE ON T A

b. EFFECT OF RICE ON pH

c. EFFECT OF RICE ON GEL STRENGTH

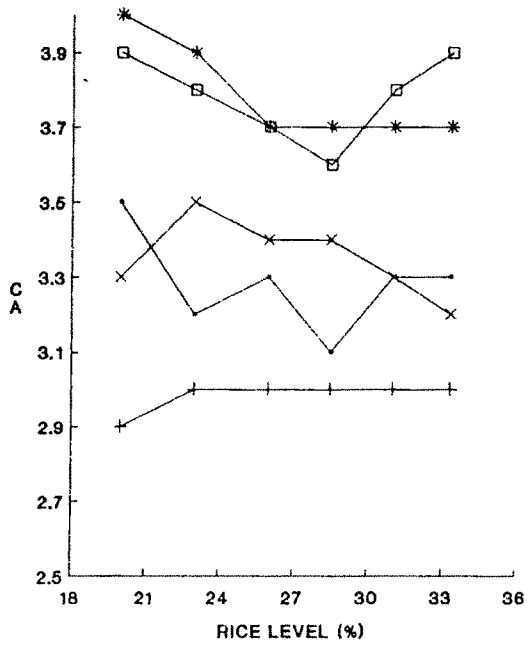
Figure 5.13 Effect of rice on TA, pH and gel strength characteristics of cheese cake Prepared with sucrose : Lactose (S:L) and whey : RSM (W:M) system.

Highest setting temperature of 80°C showed significant reduction ($p < 0.01$) in gel strength compared to controls and the gel strength of products heated at 75°C, especially at the lower levels of rice incorporation. The gel strength values ranged between 71-88 g which were comparatively lower than the gel strength values obtained at 60 and 65°C.

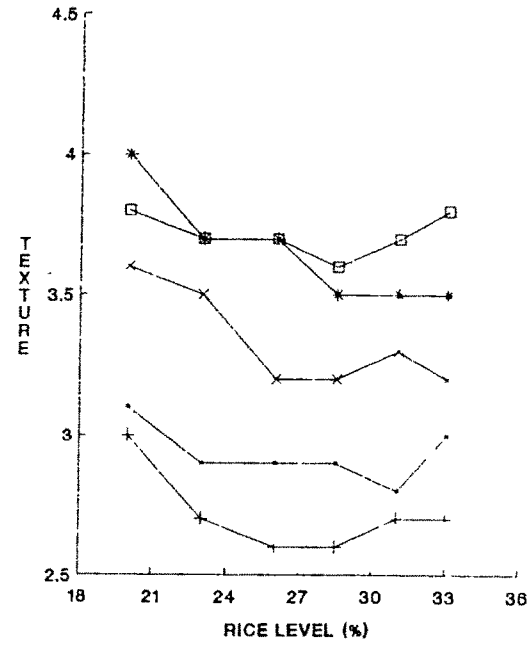
Among the setting temperatures used in the preparation of cheese cake maximum gel strength was achieved with the setting temperature of 75°C ranging from 82-91g. The gel strength increased with an increase in the proportion of rice from 20-33.3 % level at this temperature. The gel strength values of 82.7 g with 20 % rice was not significantly different from that of controls.

Results of sensory evaluation of the products developed with different proportion of rice and setting temperatures are presented in terms of colour and appearance, flavour, body & texture and overall acceptability in Fig 5.14.a-d, and the data subjected for statistical analysis is presented in Ap. no 9.15 and 9.16.

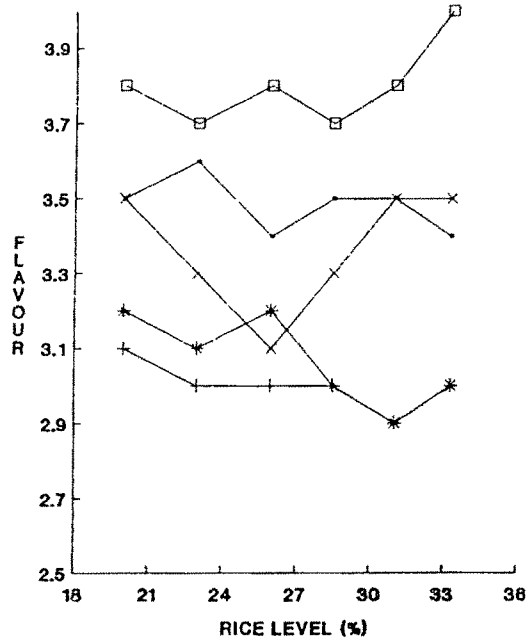
The mean scores of body and texture for the products prepared at 60-65°C were slightly lower ranging from 2.6-3.1, particularly when the concentration of rice was increased above



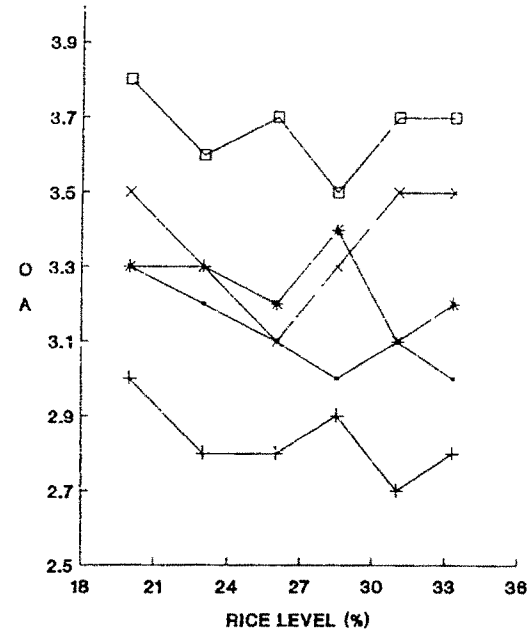
a. EFFECT ON COLOUR AND APPEARANCE



b. EFFECT ON BODY AND TEXTURE



c. EFFECT ON FLAVOUR



c. EFFECT ON OVERALL ACCEPTABILITY

Figure 5.14 : Sensory evaluation of cheese cake prepared with rice at different proportions and setting temperatures.
Setting Temp — 60°C — 65°C — 70°C — 75°C — 80°C

30 % compared to the products prepared with higher setting temperatures. Cheese cake prepared at the setting temperature of 70 and 75^{o}C obtained much higher scores 3.2-4.0 and were found to be significantly higher compared to products prepared at 65^{o}C.

Flavour scores of the products prepared with the setting temperature of 60-70^{o}C were lower ranging from 2.9-3.2 compared to products prepared at higher temperatures but the difference was not found to be statistically significant. Among the setting temperatures, 75^{o}C was found to result in products with higher flavour scores ranging from 3.7-4.0 .

Overall acceptability scores of the products prepared at 60 and 65^{o}C were found to be much lower ranging from 2.7-3.1 compared to those of products prepared at higher setting temperature, which ranged between 3.1-3.7. Significant difference ($p<0.01$) was found between the products prepared at 65 and 75^{o}C with the rice substitution at 31 - 33.3 g %.

Among different setting temperatures used, products prepared at the setting temperature of 75^{o}C gave desirable results on sensory evaluation, therefore setting temperature of 75^{o}C was selected for further studies with whey-RSM systems.

Cheese cakes were prepared from whey-RSM containing muska systems with 20-33.3 % addition of rice and a setting temperature of 75°C. Data on TA, pH and gel strength of the cheese cakes prepared with soy-muska containing whey-RSM and sucrose - lactose system is summarised in Table 5.6.

Table 5.6 Physico-chemical and Sensory properties of Egg and Rice based cheese cakes

Characteristics	Egg Control						Rice-Based Cheese Cake with Soy-Muska containing											
	Concentration of Egg (g %)						Sucrose and Lactose						Whey and RSM					
							Concentration of Rice (g %)											
	20	23	26	28	31	33	20	23	26	28	31	33	20	23	26	28	31	33
TA (% la)	0.73	0.72	0.73	0.73	0.72	0.72	0.79	0.75	0.74	0.72	0.70	0.69	0.82	0.80	0.80	0.78	0.77	0.76
pH	4.66	4.69	4.76	4.78	4.81	4.82	4.47	4.49	4.51	4.52	4.55	4.56	4.43	4.44	4.45	4.48	4.49	4.51
Gel strength (g)	82.23	91.33	101.1	107.9	113.7	119.1	82.73	84.03	85.63	90.00	91.27	91.67	83.33	85.63	87.67	89.00	90.00	93.00
Sensory Properties:																		
1) Colour and Appearance	4.0	3.9	4.0	3.9	4.0	3.9	3.9	3.8	3.7	3.6	3.8	3.9	3.8	3.7	3.7	3.7	3.7	3.8
2) Texture	3.8	3.6	3.5	3.7	3.4	3.6	3.8	3.7	3.7	3.6	3.7	3.8	4.0	3.7	3.6	3.5	3.6	3.5
3) Flavour	3.8	3.5	3.4	3.6	3.3	3.7	3.8	3.7	3.8	3.7	3.8	4.0	3.6	3.4	3.3	3.4	3.5	3.5
4) Overall acceptability	3.8	3.5	3.4	3.6	3.3	3.7	3.8	3.6	3.7	3.5	3.7	3.7	3.8	3.6	3.5	3.5	3.5	3.6

The TA and pH values of the sugar-muska-rice were not significantly different from those of sugar-muska-rice mix of sucrose-lactose system. The TA values were found to be slightly higher ranging from 0.76-0.82 % l.a. compared to the TA values of 0.72-0.73 % l.a. of egg controls and the TA values of 0.69-0.79 % l.a. of sucrose lactose containing systems. Similarly, the pH values were found to be lower ranging from 4.43-4.51 compared to the control pH range of 4.66-4.82 and the pH of 4.47-4.56 of sucrose-lactose containing systems.

The gel strength values of the cheese cake prepared with muska containing sucrose - lactose and whey-RSM are presented in Table 5.6. Setting temperature of 75^{o}C resulted in the gel strength values of 83-93g and were not found to be significantly different from the cheese cake prepared with sucrose-lactose containing systems which obtained the gel strength values of 82.7 - 91.6g.

Sensory evaluation of the cheese cake prepared with whey-RSM containing muska showed no significant difference in terms of colour & appearance, body & texture, and flavour compared to the products prepared with sucrose-lactose containing systems. The scores were between 3 to 4 indicating that the products are desirable. The over all acceptability scores ranged between 3.6-3.8 and showed slight lowering trend with increasing

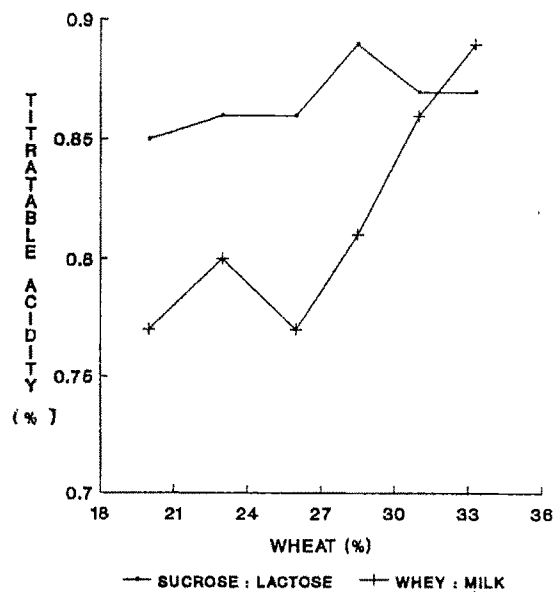
concentrations of rice. Since the products prepared at 75°C with sucrose-lactose and whey-RSM systems did not vary significantly with increasing concentrations of rice, minimum proportion of 20 % which obtained the sensory scores equivalent to those of controls was considered to be the best proportion of rice substitution at the setting temperature of 75°C.

5.2.2.2 Optimisation of concentration level and setting temperature for wheat

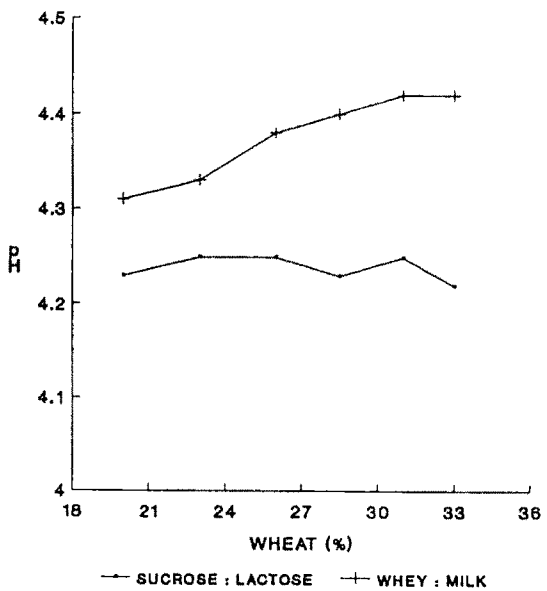
Wheat paste prepared from soaked wheat was used in the preparation of cheese cake. Wheat paste as a thckening agent was first combined with muska obtained from sucrose-lactose containing system at different proportions ranging from 20 to 33.3% level to select appropriate setting temperature. The setting temperature which gave the desirable results was used in the preparation of cheese cake with the muska obtained from whey-RSM containing systems.

The physico-chemical characteristics such as TA, pH and gel strength of muska mix and cheese cake with wheat are presented in Fig 15.a-c.(detailed data in Ap.no. 9.11 and 9.12).

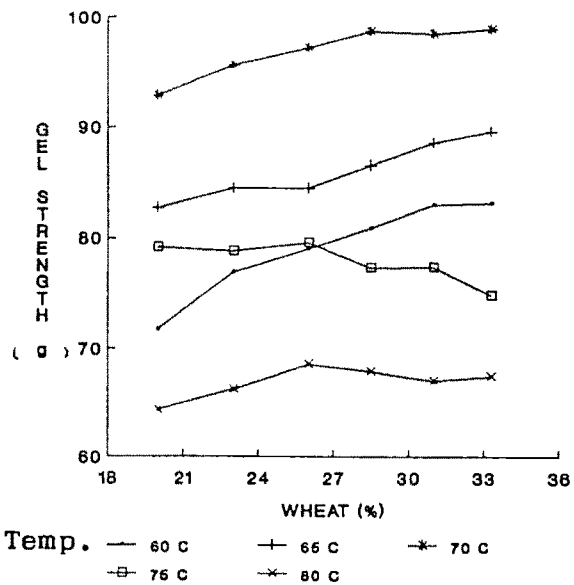
Combination of wheat paste with sugar-muska mix showed slightly higher acidity values ranging from 0.85 to 0.89 % lactic



a. EFFECT OF WHEAT ON T A



b. EFFECT OF WHEAT ON pH



c. EFFECT OF WHEAT ON GEL STRENGTH

Figure 5.15 Effect of wheat on TA, pH and gel strength characteristics of cheese cake.

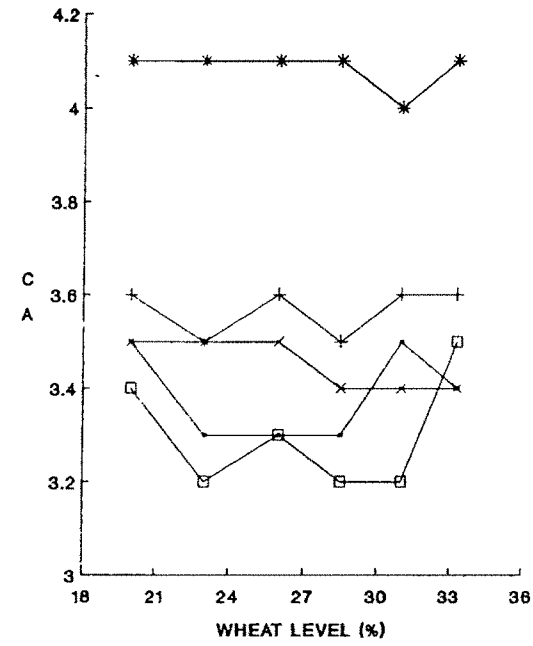
acid compared to egg controls and rice mix. The increase in the titratable acidity values showed no significant correlation with the increase in the proportion of wheat added. The pH of the muska mix with added wheat was between 4.22-4.25, comparatively lower than that of the controls prepared with egg. As can be seen from Fig 5.15.c, the gel strength values in general increased along with the increasing wheat concentrations at setting temperatures of 60, 65 and 70°C. Upto the setting temperature of 70°C, increasing the setting temperature increased gel strength. Depending on the level of wheat addition, the gel strength of cheese cakes ranged from 71-83 g at 60°C setting temperature to 92-98 g at 70°C. Further increase in the temperature to 75°C and 80°C for 30 minutes caused a reduction in gel strength compared to controls. The gel strength values were between 79-74 g at 75°C and 64-67 g at 80°C. The gel strength values of 64-67 g obtained at 80°C were found to be significantly lower ($p<0.01$) compared to controls at all the levels of wheat substitution.

Among the setting temperatures utilized in the preparation of cheese cake with wheat, heat treatment of 70°C for the duration of 30 minutes gave best result in terms of gel strength. The gel strength values of 92-95 g obtained at 70°C with 20 and 23 g % wheat addition were found to be higher compared to the gel strength of 82 g obtained with egg at 20 %.

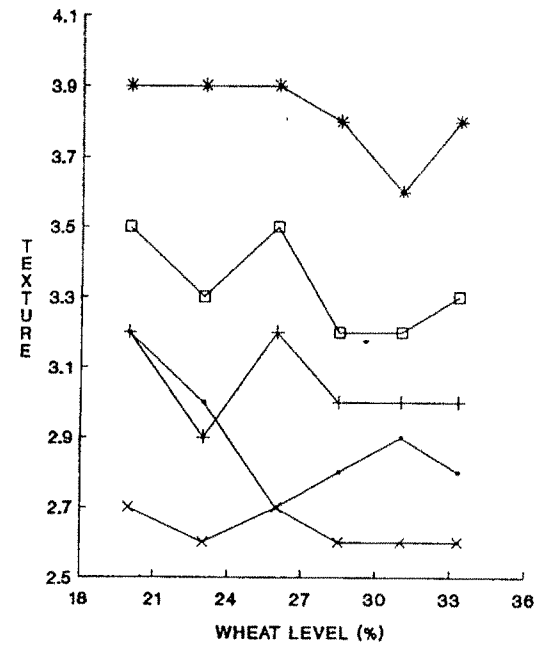
Results of the sensory evaluation of the cheese cake prepared with the addition of wheat are presented in Fig 5.16. a-d,and the data detailed in Ap. no. 9.17 and 9.18.

Mean scores for body and texture of the products prepared at the setting temperature of 70°C ranged between 3.6 to 3.9, and were found to be significantly higher ($p < 0.001$) compared to the products obtained at the setting temperatures of 60, 65 and 80°C at all the levels of wheat addition. Mean scores of products set at 75°C were found to be slightly lower compared to products prepared with the setting temperature of 70°C but the difference was not statistically significant.

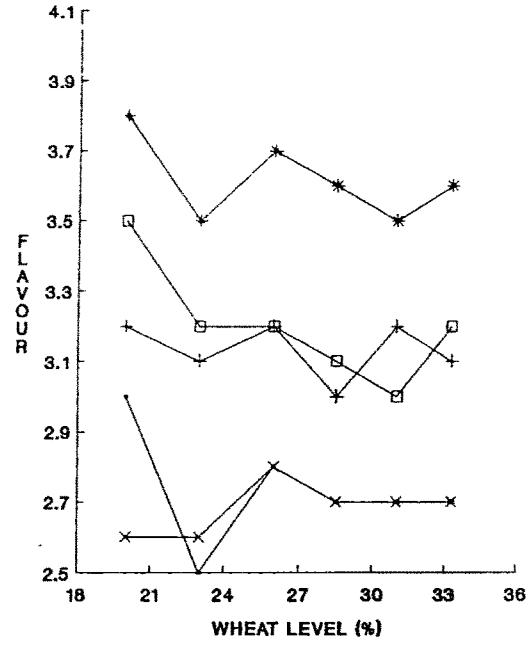
Flavour scores of the products prepared with different levels of wheat substitution showed improvement with the increase in the setting temperature from 60°C to 75°C. Setting temperature above 75°C i.e. products prepared at 80°C obtained scores ranging from 2.6-2.8 which were found to be significantly lower ($p<0.001$) compared to the mean flavour scores of products prepared at 70°C with different levels of wheat substitution. Significant difference ($p<0.001$) was also found between the scores of products prepared at 60°C with wheat substitution above 26 % compared to products prepared at 70°C.



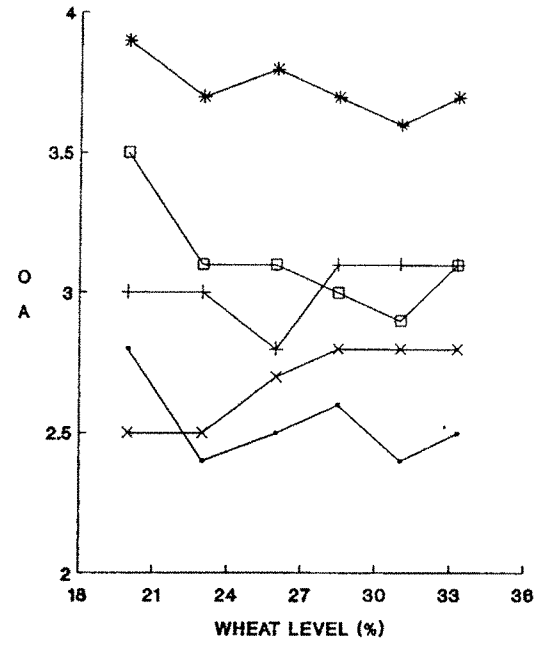
a. EFFECT ON COLOUR AND APPEARANCE



b. EFFECT ON BODY AND TEXTURE



c. EFFECT ON FLAVOUR



d. EFFECT ON OVERALL ACCEPTABILITY

Figure 5.16 : Sensory evaluation of cheese cake prepared with wheat at different proportions and setting temperatures.

Setting Temp. — 60°C — 65°C — 70°C — 75°C — 80°C

Overall acceptability scores showed improvement with the increasing temperature from 60 to 75°C. Cheese cake prepared at the setting temperature of 60 and 65°C ranged between 2.4-3.1 against the scores of 3.6-3.9 of the products prepared at 70°C. The scores of products prepared at the setting temperature of 80°C and 60° C were found to be significantly lower ($p<0.001$) compared to products prepared at 70°C with 20 to 33.3 % wheat levels.

Products prepared at 60, 65 and 80°C were considered to be inferior in terms of textural and flavour characteristics and were rejected. Since the products prepared at 70°C obtained desirable scores on sensory evaluation the setting temperature of 70°C was selected for studies with whey-RSM.

Results on the physico-chemical and sensory characteristics of cheese cakes prepared with muskas containing whey-RSM and sucrose - lactose containing system are summarised in Table 5.7.

Addition of wheat paste prepared with soaked wheat to soy muska containing whey-RSM gave similar results interms of TA, pH and gel strength as observed with sucrose-lactose containing systems. The TA values ranged between 0.77-0.89 % .la. and showed

slight increasing trend with the increase in the proportion of wheat particularly when the addition was increased above 28 g %.

Table 5.7 Physico-chemical and Sensory properties of Egg and Wheat based cheese cakes.

Characteristics	Egg Control						Wheat-Based Cheese Cake with Soy-Muska containing											
	Concentration of Egg (g %)						Sucrose and Lactose						Whey and RSM					
	Concentration of Wheat (g %)																	
	20	23	26	28	31	33	20	23	26	28	31	33	20	23	26	28	31	33
TA (% la)	0.73	0.72	0.73	0.73	0.72	0.72	0.85	0.86	0.86	0.89	0.87	0.87	0.77	0.80	0.77	0.81	0.86	0.89
pH	4.66	4.69	4.76	4.78	4.81	4.82	4.23	4.25	4.25	4.23	4.25	4.22	4.31	4.33	4.38	4.40	4.42	4.42
Gel strength (g)	82.23	91.33	101.1	107.9	113.7	119.1	92.9	95.6	97.17	98.7	98.5	98.93	88.33	91.33	92.0	95.0	95.67	98.67
Sensory Properties:																		
1) Colour and Appearance	4.0	3.9	4.0	3.9	4.0	3.9	4.1	4.1	4.1	4.1	4.0	4.1	3.6	3.6	3.5	3.5	3.6	3.4
2) Texture	3.8	3.6	3.5	3.7	3.4	3.6	3.9	3.9	3.9	3.8	3.6	3.8	3.8	3.8	3.7	3.7	3.6	3.5
3) Flavour	3.8	3.5	3.4	3.6	3.3	3.7	3.8	3.5	3.7	3.6	3.5	3.6	3.6	3.7	3.4	3.6	3.6	3.5
4) Overall acceptability	3.8	3.5	3.4	3.6	3.3	3.7	3.9	3.8	3.7	3.7	3.6	3.7	3.7	3.6	3.4	3.6	3.5	3.5

The gel strength values were slightly lower ranging from 88 to 98g against the gel strength values of muska-mix obtained from sucrose and lactose systems which ranged between 92 to 98g. However, the reduction in the gel strength values did not show any statistical significance.

Sensory evaluation of cheese cake prepared with the setting temperature of 70^{o}C, from the muska obtained from soymilk containing whey-RSM obtained slightly lower scores for overall acceptability ranging from 3.5-3.7 compared to the scores of 3.7 - 3.9 of products prepared with the muska prepared from sucrose-lactose containing systems. This was due to a characteristic flavour associated with wheat addition. However in both cases of sugar systems increasing proportion of wheat above 20 % did not improve the product characteristics. Therefore **minimum proportion of 20 % and setting temperature of 70^{o} C was selected as best combinations with wheat.**

5.2.2.3 Optimisation of concentration level and setting temperature for potato

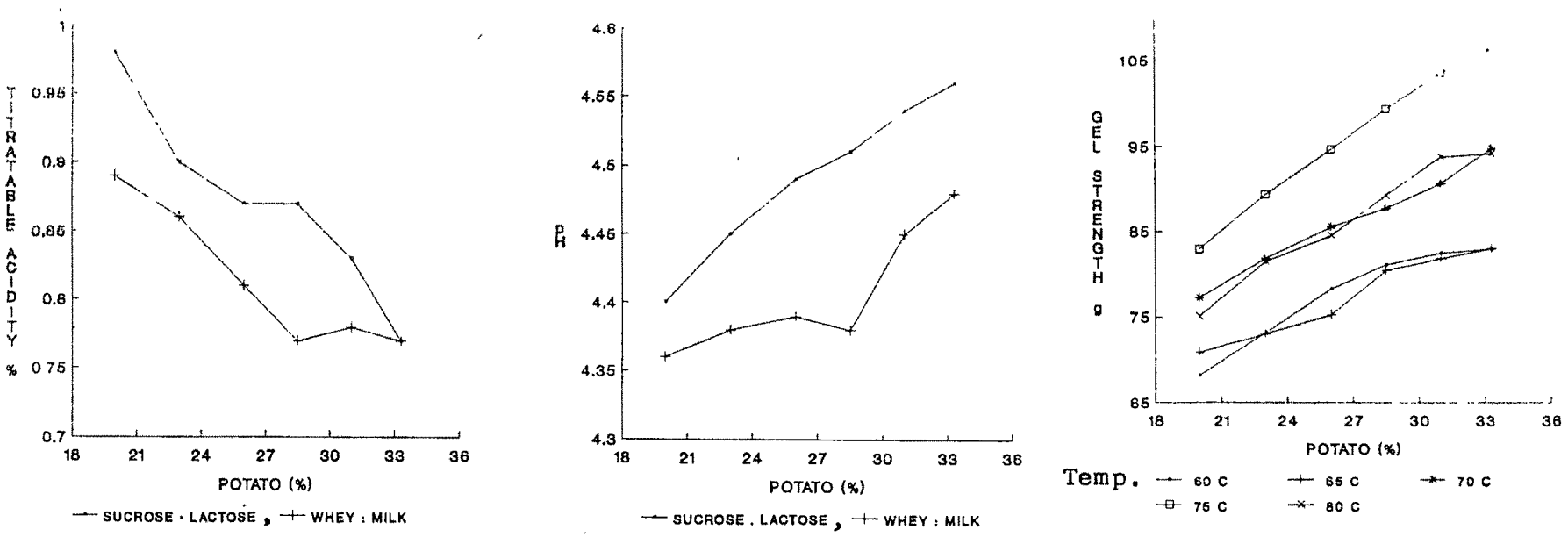
Potato paste prepared from boiled and deskinned potato was used as a thickening agent at levels ranging from 20 - 33.3%, in the preparation of cheese cake at different setting temperatures.

After establishing the desirable setting temperature with sucrose-lactose containing system, the cheese cake was prepared with the muska obtained from whey-RSM containing system.

The effect due to the addition of potato on the sugar-muska mix and the effect of setting temperature on the gel strength of cheese cake is graphically presented in Fig 5.17.a-c, and the data detailed in Ap. no. 9.11 and 9.12.

Addition of potato mix to sugar-muska mix caused slight decrease in the titratable acidity with the increasing concentrations. TA values ranged between 0.77 to 0.98 % l.a. with pH ranging from 4.4-4.56 and were not found to be significantly different from that of controls prepared with egg.

It is clear from Fig 5.17.c, the increasing proportion of potato caused an increase in gel strength which was observed with all the setting temperatures. Increase in the setting temperature from 60 to 75^{o}C caused a significant increase ($p<0.05$) in gel strength. Setting temperature above 75^{o}C caused a significant reduction ($p<0.05$) in gel strength at all levels of potato incorporation. The gel strength values at 80^{o}C temperature of setting ranged between 75-94 g. The gel strength values of 82 g obtained with minimum proportion of potatoes at the setting



a. EFFECT OF POTATO ON T.A.

b. EFFECT OF POTATO ON pH

c. EFFECT OF POTATO ON GEL STRENGTH

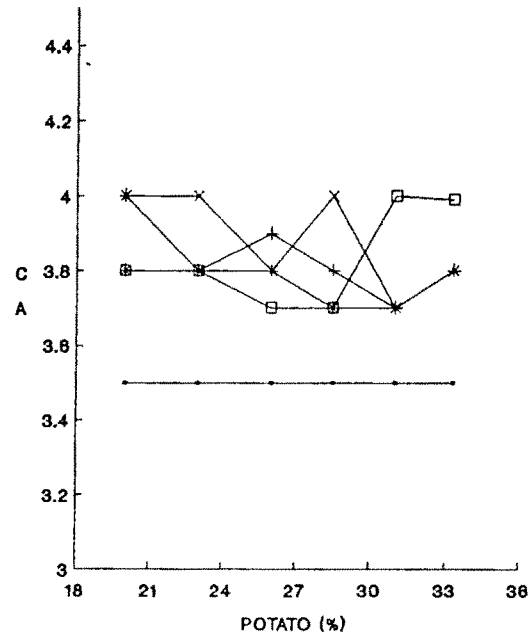
Figure 5.17 : Effect of potato on TA, pH and gel strength characteristics of cheese cake.

temperature of 75°C was found to be not significantly different from that of controls.

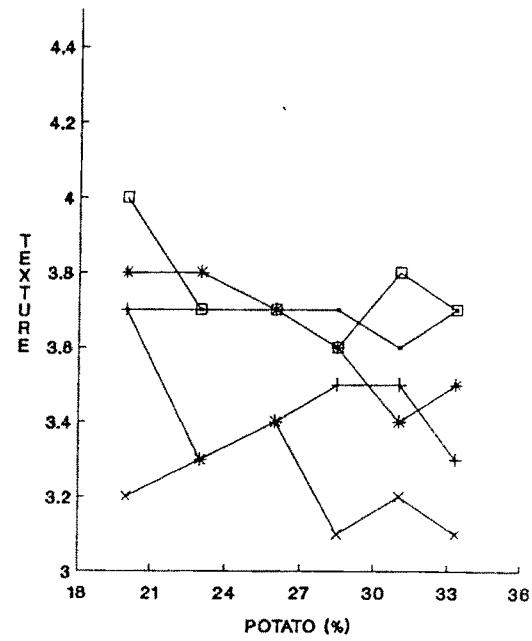
Results of sensory evaluation of the products prepared with the addition of potatoes are presented in Fig 5.18.a-d. (Data with statistical analysis is presented in Ap.no.9.19 & 9.20).

The increase in the setting temperature from 60-75°C, showed only slight increase in the textural scores ranging from 3.7-4.0 for the products prepared with different proportion of potatoes. Increasing the setting temperature above 75°C caused slight reduction in the textural scores to the level of 3.1-3.4. The flavour scores of 3.0-3.7 for the products prepared at 65 and 80°C were found to be lower compared to the products prepared at 60 and 75°C. Among different setting temperatures used 75°C gave slightly higher scores at all the levels of potato substitution but was not found to be significantly different from the products prepared at lower temperatures.

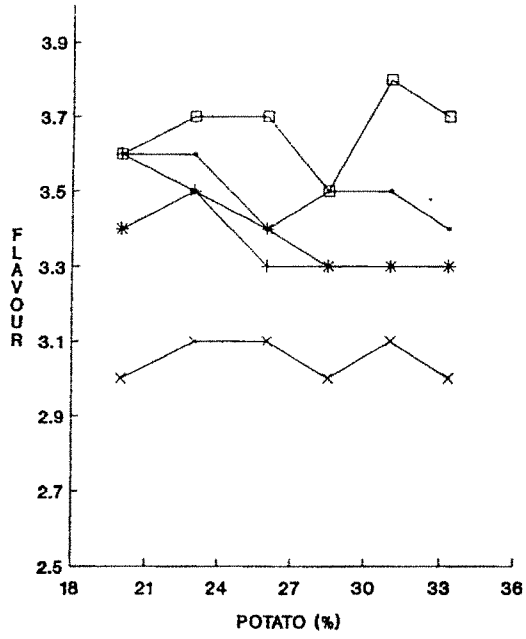
The overall acceptability scores of the products did not show any consistent pattern of improvement with the increase in the setting temperature. Products prepared at lower temperatures such as 60 and 65°C showed slightly lowering of scores with the increase in the level of potatoes. Among various setting temperatures, products prepared at 80°C obtained lowest scores



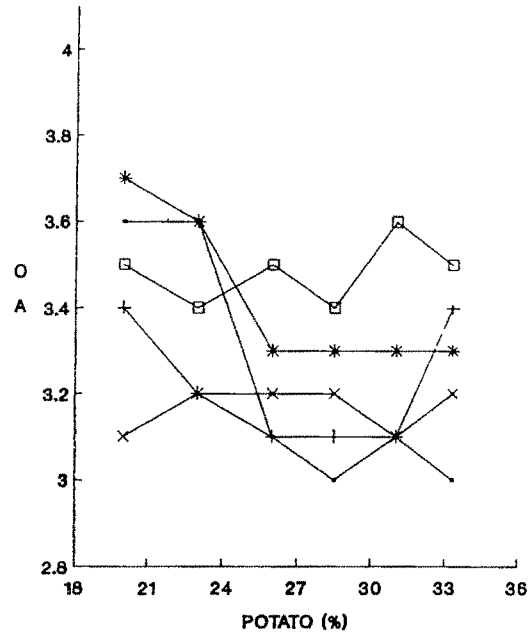
a. EFFECT ON COLOUR AND APPEARANCE



b. EFFECT ON BODY AND TEXTURE



c. EFFECT ON FLAVOUR



d. EFFECT ON OVERALL ACCEPTABILITY

Figure : 5.18 Sensory evaluation of cheese cake prepared with potato different proportions and setting temperatures.

Setting Temp. — 60°C — 65°C — 70°C — 75°C — 80°C

ranging from 3.1-3.2. The setting temperature of 75°C resulted in products with higher over all acceptability scores ranging from 3.4-3.6, however the difference was not found to be significant from the scores of products prepared at 60 and 80°C. Therefore setting temperature of 75°C which yielded products with most desirable characteristics was used in the preparation of cheese cake with muska obtained from whey-RSM containing systems.

The results on TA, pH, gel strength and sensory characteristics of cheese cakes prepared from whey-RSM and sucrose- lactose containing muskas with the addition of potato are summarised in Table 5.8.

The TA values of of the cheese cake mix prepared with whey-RSM systems ranged between 0.77-0.89 % l.a. against the TA values of 0.77 - 0.98 % l.a. of sucrose-lactose containing systems with different proportion of potato. The pH values ranged between 4.36-4.48 and were found to be slightly lower compared to control values of 4.66-4.82 prepared with egg.

The muska obtained from whey-RSM system used in the preparation of cheese cake developed a product with slightly lower gel strength values ranging from 82 to 104 g, set at the heating temperature of 75°C compared to the gel strength values of sucrose-lactose systems which ranged between 82-106.4 g.

Table 5.8 Physico-chemical and Sensory properties of Egg and Potato based cheese cakes

Characteristics	Egg Control						Potato-Based Cheese Cake with Soy-Muska containing											
	Concentration of Egg (g %)						Sucrose and Lactose						Whey and RSM					
							Concentration of Potato (g %)											
	20	23	26	28	31	33	20	23	26	28	31	33	20	23	26	28	31	33
TA (% la)	0.73	0.72	0.73	0.73	0.72	0.72	0.98	0.90	0.87	0.87	0.83	0.77	0.89	0.86	0.81	0.77	0.78	0.77
pH	4.66	4.69	4.76	4.78	4.81	4.82	4.40	4.45	4.49	4.51	4.54	4.56	4.36	4.38	4.39	4.38	4.45	4.48
Gel strength (g)	82.23	91.33	101.1	107.9	113.7	119.1	82.8	89.3	94.6	99.2	103.3	106.4	82.0	85.3	92.7	97.7	100.0	104.3
Sensory Properties:																		
1) Colour and Appearance	4.0	3.9	4.0	3.9	4.0	3.9	3.8	3.8	3.7	3.7	4.0	3.9	4.0	4.0	3.8	4.0	3.7	3.8
2) Texture	3.8	3.6	3.5	3.7	3.4	3.6	4.0	3.7	3.7	3.6	3.8	3.7	4.0	3.8	3.8	3.7	3.6	3.6
3) Flavour	3.8	3.5	3.4	3.6	3.3	3.7	3.6	3.7	3.7	3.5	3.8	3.7	3.7	3.7	3.6	3.5	3.6	3.6
4) Overall acceptability	3.8	3.5	3.4	3.6	3.3	3.7	3.5	3.4	3.5	3.4	3.6	3.5	3.7	3.7	3.5	3.3	3.5	3.3

Sensory evaluation of cheese cake prepared with whey-RSM containing muska obtained scores of 3.7-4.0 and were found to be similar to that of cheese cakes prepared with sucrose-lactose containing systems. The flavour and over all acceptability scores

showed slight lowering trend with the increase in the proportion of potato added and ranged between 3.3-3.7. Difference in the proportion of potatoes in the cheese cake did not alter the acceptability characteristics significantly at the setting temperature of 75°C. Therefore cheese cakes prepared at 75°C with lowest proportion of potatoes (i.e 20 g %) which obtained the gel strength and sensory characteristics equivalent to that of controls was selected for further studies.

5.2.2.4 Effect of bay leaves and lemongrass treatment

Similar to the approach attempted with egg controls, cheese cake was also prepared with the sugar-muska obtained from lemongrass (0.1%) and bay leaf treated (0.1 %) soymilk. Thickening agents such as rice, wheat, and potato were added at 20 g% levels, and the heat treatment of 75°C in the case of rice and potato and 70°C with wheat for 30 min was used for setting of cheese cakes.

Results of sensory evaluation of the bay leaves and lemongrass treated products are summarised in Table 5.9.

Sensory evaluation of the products treated with bay leaf showed slight improvement in flavour scores ranging from 4.3-4.4 of products prepared with rice, wheat and potato compared to the

scores of 3.6-3.8 of the products prepared without bay leaf treatment. But the improvement on the scores were not found to be statistically significant. Similarly, overall acceptability scores, which ranged between 4.2-4.3 also showed non-significant improvement with bay leaf treated products. Lemongraas treated products showed slightly lower scores of 3.6-3.8 for flavour and overall acceptability compared to bay leaf treated products, however the scores were not found to be significantly different from those of controls.

Table 5.9 Sensory scores of cheesse cakes with rice, wheat and potato added to muskas prepared from soy milks treated with bay leaf and lemon grass

Sensory Attributes	Controls			Bay Leaf Treated			Lemon Grass Treated		
	RICE	WHEAT	POTATO	RICE	WHEAT	POTATO	RICE	WHEAT	POTATO
Colour & Appearance	3.9	3.6	3.8	3.6	3.7	3.8	3.8	4.0	4.0
Body & Texture	3.8	3.8	4.0	4.1	4.1	4.1	3.8	3.8	4.0
Flavour	3.8	3.6	3.6	4.3	4.4	4.3	3.6	3.8	3.8
Overall Acceptability	3.8	3.7	3.5	4.2	4.3	4.3	3.8	3.8	3.7

The above results on the optimisation of concentration level and setting temperature in the preparation of cheese cakes with the addition of rice, potato and wheat indicate that

their addition at the minimum level of 20 % was adequate to substitute egg in cheese cakes with most desirable sensory attributes. The best temperature for 30 minutes setting turned out to be 75°C for rice and potato, and 70°C for wheat. Eventhough, the products prepared with these ingredients scored as good as those prepared with eggs, the products in general did not obtained the scores in the "liked very much " category including egg based products due to their flavour and colour characteristics.

5.2.2.5 Addition of colouring and flavouring agents

From the earlier studies it was observed that the physico-chemical and sensory properties of the cheese cake prepared with muskas obtained from sucrose-lactose containing soymilk systems did not differ much from the muskas obtained from whey-milk containing sytems. Therefore, only sucrose-lactose containing sytems were utilised for the flavour and storage studies.

In order to further improve the flavour and colour attributes of the products, several flavouring and colouring agents were added prior to heat setting of cheese cake. Flavours selected for this purpose were vanilla, cardamom, orange, pineapple, lemon and mango. Yellow and Orange liquid colour preparations were used in different concentrations to create lighter and deeper shades and were used appropriately with the

flavoured products. Since the treatments such as lemongrass and bay leaves might have some influence on the artificial flavouring agents used, combination of bay leaves with cardamom, and the combination of lemongrass treatment with lemon, pineapple, orange and mango were also tried out. Of these vanilla and cardamom containing samples had no added colour.

The colour, flavour and treatment combinations used for others are presented in Table 5.10.

Table 5.10 Selection of flavour and colour Combinations

Sr No	Flavour	Treatment	Conc. (ml in 100g mix)	Colour	Conc. (ml in 100g mix
1	Vanilla	-	4	-	
2	Vanilla	-	6	-	
3	Cardamom	-	0.1 g%	-	
4	Cardamom	-	0.2 g%	-	
5	Cardamom	Bay leaf	0.1 g%	-	
6	Lemon	-	4	Lemon-yellow)	
7	Lemon	-	6	Lemon-yellow)	0.02
8	Lemon	Lemongrass	4	Lemon-yellow)	
9	Pineapple	-	4	Deep-yellow)	0.04
10	Pineapple	Lemongrass	4	Deep-yellow)	
11	Orange	-	4	Light-orange)	0.02
12	Orange	Lemongrass	4	Light-orange)	
13	Mango	-	4	Deep-orange)	0.04
14	Mango	Lemongrass	4	Deep-orange)	

Note : Liquid flavour, colour (orange) preparations of "Bush
: Boake Allen " and lemon yellow colour preparation of
: "Jamsons" were used.

Results of the sensory evaluation of cheese cake prepared with added colours and flavours are summarised in Table 5.11 and the data subjected for statistical analysis is presented in Ap.no.9.21 and 9.22.

The textural characteristics of the products did not show any change due to the addition of flavouring or colouring agents added. The body and textural characteristics of the products prepared with four different ingredients namely egg, rice, wheat or potato ranged from 3.6 to 4.8.

Colour and appearance scores of the products prepared with the addition of colouring agents ranged between 4.3-4.7 which indicated an improvement as they were in the range of "highly desirable" compared to the control scores of below 4.0. Among the products prepared with various colouring agents deep orange colour used in mango flavour caused a significant improvement ($p<0.001$) on the colour and appearance scores of all egg, rice, wheat and potato based products. Addition of light orange colour used in orange flavoured products caused significant improvement ($p<0.001$) in the colour and appearance scores of potato based products. Addition of lemon yellow colour to the pineapple flavour based products also caused a significant improvement ($p<0.001$) in potato based products. Improvement in colour and appearance scores were also observed with the products

Table 5.11 Sensory Evaluation of Cheese cakes with added colour and flavours

	EGG					RICE					WHEAT					POTATO				
FLAVOURS	CA	T	F	T*	OA	CA	T	F	T*	OA	CA	T	F	T*	OA	CA	T	F	T*	OA
VANILLA	3.7	3.8	3.5	3.7	3.5	3.8	4.1	3.3	3.7	3.5	3.5	4.2	4.0	3.9	3.8	3.5	4.8	3.8	4.0	3.9
VANILLA	3.8	3.8	3.7	3.8	3.8	3.6	3.9	3.6	3.7	3.5	3.6	4.0	3.7	3.8	3.6	4.0	3.8	4.0	3.9	3.7
BAY LEAF	3.8	4.1	4.2	4.0	4.0	3.6	4.1	4.3	4.0	4.2	3.7	4.1	4.4	4.1	4.3	3.8	4.1	4.3	4.1	4.3
CARDAMON\	3.9	3.8	4.6	4.1	4.6	3.6	3.9	4.5	4.0	4.6	3.6	3.8	4.7	4.0	4.6	3.8	4.0	4.7	4.2	4.7
CARDAMON\	4.1	4.1	4.0	4.1	4.1	3.7	4.0	3.7	3.8	3.8	4.0	4.2	3.9	4.0	4.0	4.0	4.2	4.0	4.1	4.1
CARDAMON + BL	4.1	4.2	4.3	4.2	4.5	3.7	4.1	4.4	4.1	4.5	3.9	4.2	4.4	4.2	4.4	4.1	4.3	4.6	4.3	4.6
LEMON GRASS	4.0	3.8	3.7	3.8	3.7	3.8	3.8	3.6	3.7	3.8	4.0	3.8	3.8	3.9	3.8	4.0	4.0	3.8	3.9	3.7
LEMON	3.9	4.1	4.2	4.1	4.0	3.8	4.1	3.9	3.9	3.7	3.8	4.2	4.0	4.0	3.9	3.8	4.2	4.0	4.0	4.0
LEMON	3.7	3.8	4.1	3.9	4.0	3.8	3.8	3.9	3.8	3.9	4.0	4.0	4.1	4.0	4.1	3.8	4.1	4.2	4.0	4.1
LEMON + L G	4.0	4.0	3.9	4.0	3.8	3.8	3.8	3.7	3.8	3.7	3.8	4.0	3.8	3.9	3.8	4.0	4.0	3.8	3.9	4.0
MANGO	4.6	4.3	4.3	4.4	4.3	4.6	4.2	4.2	4.3	4.2	4.6	4.2	4.2	4.3	4.2	4.7	4.2	4.3	4.4	4.3
MANGO + LG	4.7	4.3	4.2	4.4	4.2	4.5	4.3	4.2	4.3	4.2	4.7	4.4	4.3	4.5	4.5	4.5	4.2	4.2	4.3	4.2
ORANGE	4.5	4.7	4.8	4.7	4.8	4.5	4.6	4.7	4.6	4.7	4.5	4.5	4.5	4.5	4.5	4.5	4.8	4.8	4.7	4.8
ORANGE + LG	4.5	4.3	4.3	4.4	4.3	4.1	4.1	4.1	4.1	4.1	4.3	4.4	4.3	4.3	4.4	4.3	4.3	4.2	4.3	4.2
PINE APPLE	4.6	4.4	4.6	4.5	4.6	4.3	4.5	4.7	4.5	4.4	4.4	4.4	4.6	4.5	4.3	4.5	4.4	4.7	4.5	4.4
PINE APPLE + LG	4.3	4.4	4.5	4.4	4.6	4.5	4.3	4.3	4.4	4.3	4.5	4.6	4.3	4.5	4.5	4.3	4.5	4.5	4.4	4.6

C A : Colour & Appearance ; T : Body & Texture

F : Flavour ; O A : Overall acceptability

* Addition of component scores and dividing by 3.

prepared with lemon yellow colour in the lemon flavour based products. However, the increase was found to be not statistically significant, compared to those of products prepared without the addition of colour.

The mean flavour scores of the products prepared with various flavours ranged between 3.5-4.8 compared to scores of 3.0 to 3.8 of the controls prepared without the addition of flavouring agents. Significant improvement ($p<0.001$) in the flavour scores of egg, rice, wheat and potato based products were observed with orange, cardamom and pineapple flavoured products. Among these acceptable flavours, orange flavour caused a maximum level of improvement on flavour scores (from 3.5 for controls to 4.8 for flavoured products). Cheese cake prepared with 0.1 g % cardamom showed significant improvement in flavour scores ranging between 4.5-4.7. Increasing the concentration of cardamom to 0.2 g % did not cause any further significant improvement on flavour scores compared to the products prepared with 0.1 g % cardamom.

Addition of mango as a flavouring agent caused significant ($p<0.001$) improvement on the flavour scores of the products prepared with wheat and potato based prducts but caused only a slight increase in flavour scores of rice and wheat based cheese cakes.

Eventhough the scores of products prepared with the addition of lemon, vanilla were slightly higher ranging from 3.5-4.0, no significant improvement of the flavour scores were observed with these products. Vanilla found to have the lowest effect on the improvement of flavour scores of the products. The scores were below 4.0. The addition of vanilla and lemon flavour in higher concentrations such as 6 ml in 100 g mix did not result in any significant improvement on the flavour scores of the products.

Treatment of lemongrass or bay leaves alone did not cause any significant improvement on the flavour scores of the products prepared with egg, rice, wheat or potato.

Bay leaf and lemongrass treated products showed only slight improvement in flavour scores ranging from 3.3-4.0 compared to products prepared without bay leaf or lemongrass treatment with the scores of 3.3-3.8. Bay leaves treatment combined with cardamom addition showed similar significant improvement in flavour scores compared to products prepared with only cardamom at 0.1 g% with egg,rice,wheat or potato based cheese cakes.

Similarly, products prepared only with lemongrass did not show any increase in flavour scores compared to untreated products. Products prepared with lemongrass along with flavours

such as orange or pineapple showed no significant improvement on flavour scores compared to controls.

The mean scores for overall acceptability of the products prepared with various thickening agents ranged between 3.5-4.8 with the lowest overall acceptability for the products prepared with vanilla and maximum scores for the products prepared with cardamom, orange, mango and pineapple against the control scores of less than 4.0. The improvement on the overall acceptability scores of cardamom, cardamom combined with bay leaves, mango, orange, and orange combined with lemongrass, pineapple and pineapple combined with lemongrass showed statistically significant ($p<0.001$) improvement in most of the products.

The Total Scores (obtained by adding the mean scores of colour and appearance, body and texture and flavour and dividing by 3) were also in the range of 3.7-4.8 which were found to be similar to those of Overall Acceptability (O A) in most of the products. The difference between the Total and OA scores was found to be minimum in case of orange, pineapple and lemon based products. The difference was slightly more in elaichi based products. In this case, the Total scores of colour, flavour and texture were slightly lower than the over all acceptability scores of the products.

Treatment of bay leaves or lemongrass alone caused slight improvement on the overall acceptability scores and found to be not significantly different from the controls, except the improvement with bay leaf in potato based products acceptability scores. Similarly, the addition of flavours such as vanilla, lemon, showed no significant improvement on overall acceptability of all the products.

5.2.3 Standardized Process for the Preparation of Soybean Based Cheese cake

Results of this study indicate that the cheese cake with desirable organoleptic properties can be prepared from soybean with or without the addition of egg. The manufacturing steps standardised for the preparation of cheese cake are outlined in Figure 5.19, which essentially consist of the preparation of soymilk from soybean, the conversion of soymilk to lactic curd and the subsequent conversion of soycurd, to heat clotted cheese-cake with the addition of coagulating/thickening, flavouring and colouring agents.

For the preparation of soymilk ,soybeans, soaked in water (0.5% Na_2CO_3) for 8 hrs at room temperature, were wet ground with boiling water, and passed through double layered muslin

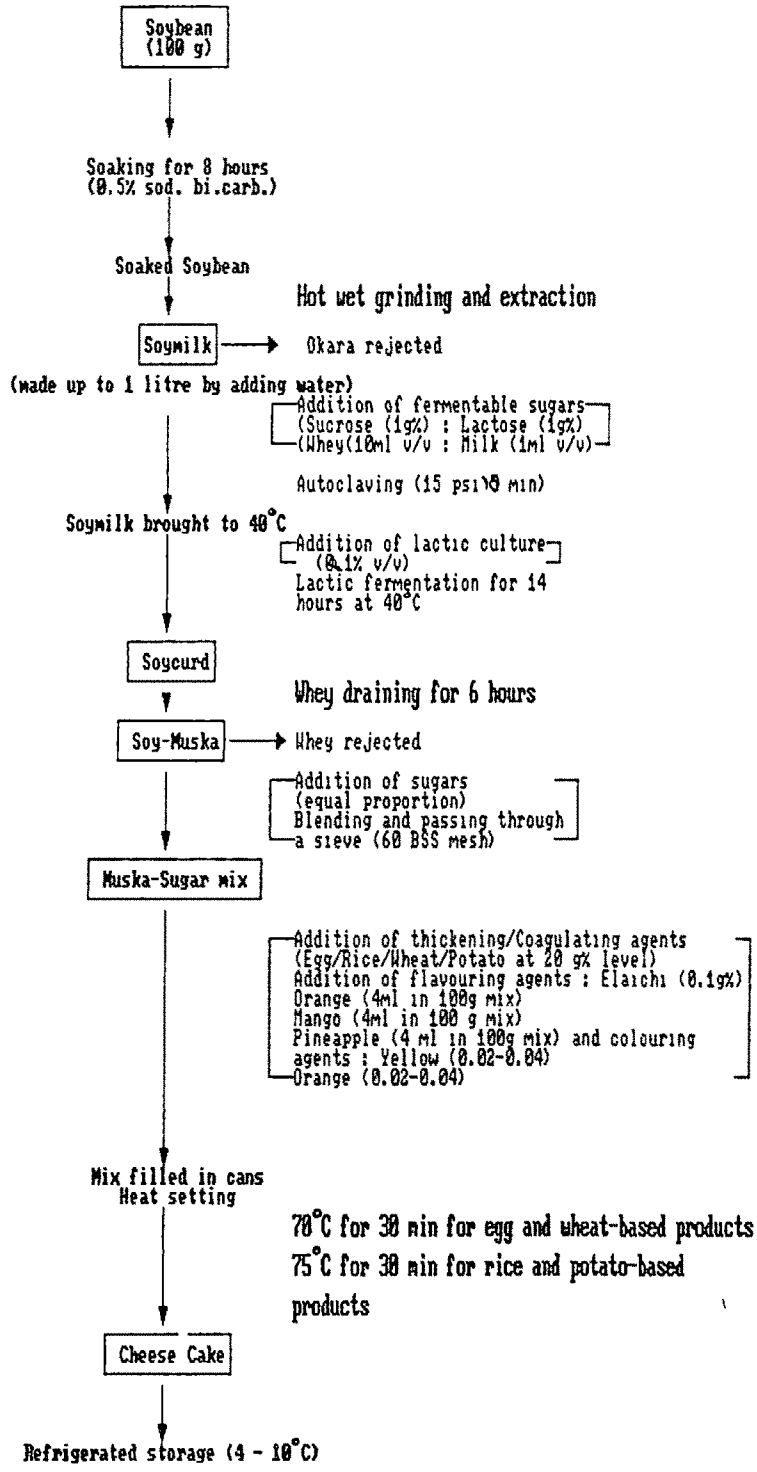


Fig. 5.19 Standardised processing steps for preparing soybased cheese cake

cloth to separate the residue , okara, from milk. Soymilk thus obtained was supplemented with a combination of sucrose and lactose (1g% each) or whey (10 % v/v) and RSM (1% v/v), autoclaved for 10 min at 15 psi, and cooled to 40^{o}C. Lactic culture was added at 1% level to soymilk and incubated at 40^{o}C for 14 hours. Soycurd, obtained this way, had a DTA of 0. 6% l.a., with pH ranging between 4 and 4.5, with the curd strength above 30 gms.

Soy curd was collected in a double layered muslin cloth and hung freely for 6 hours to promote maximum whey removal. The resulting muska was blended with an equal portion of sugar and worked through a sieve (60 BSS mesh) to obtain a lump free sugar-muska mix. The sugar-muska mix was then blended with 20 % coagulating or thickening agents namely whole egg, or other textural modifiers, such as rice, wheat, or potato pastes. These pastes were prepared by heating the slurries of soaked rice or wheat at 75^{o}C for 10 min, and by mashing the deskinned boiled potato. Flavouring agents such as ground cardamom (0.1 g%), or artificial orange, mango, pineapple, and lemon essence (4 ml per 100g), and colouring agents such as orange and yellow preparations at two different concentration levels (0.02 & 0.04 ml in 100 g mix) were also added at this stage.

After a thorough mixing of thickening agents,essence and colour with the sugar - muska mixture, the mass was filled in aluminium or stainless steel cups in 75 g amounts, Aluminium foil or Stainless Steel lids were placed on top of the containers, and a heat setting treatment was given at $70^{o}C$ for 30 minutes for egg and wheat based products, and $75^{o}C$ for 30 minutes in case of products prepared with rice and potato. The cheese cakes were then cooled and stored in refrigerator (4 - $10^{o}C$) until further use.

Cheese cakes prepared with the above procedure, yielded a product with a titratable acidity of 0.7-1 g% lactic acid, pH ranging from 4.2 to 4.6, and gel strength of 80-90 g. With the added flavours such as cardamom, orange, lemon and pineapple which are commonly used in acidic and sweetened dairy products, the soy based cheese cakes were favourably received with an overall acceptability score above 4, i.e "liked very much catagory". Prior to the commercial exploitation of these products, test marketing with a larger population would ofcourse have to be undertaken.

5.3 Characterization of Cheese cakes in terms of Composition, Microbiological and Shelf-life Characteritics

In the final phase of experimentation, studies were conducted to determine the recovery of solids during the various phases of converting soybean to soy "muska", the compositional aspect of the cheese cake prepared according to the standardized procedure outlined in Section 5.2.3 Page no. 5.83 and sensory and microbiological quality of the products during 90 days of storage at 4-10^{o}C.

The results on the characterization of the standardized products are presented under the following heads:

5.3.1 Gross compositional changes during the conversion of soybean to soy muska

5.3.2 proximate composition of cheese cakes

5.3.3 Sensory and microbiological characteristics of cheese-cakes during refrigerated storage.

5.3.1 Gross compositional changes during different stages of muska preparation

The gross compositional characteristics of starting material i.e. soybean, and subsequent intermediate products, such as soymilk, okara, soymuska and whey were analysed in terms of

moisture, protein, fat, carbohydrate and ash. From this data, the recovery of soysolids were calculated for two different stages of conversion i.e. soybean to soy milk and okara and from soycurd to soymuska,and whey. Partitioning of soysolids between soymilk and okara , soymuska and whey were also calculated.

The results of gross compositional changes in the conversion of soybean to soymuska are presented in Table 5.12. The starting material i.e. soybean was composed of 38.3 % protein, 18.9 % fat, 29.8 % carbohydrate and 5.75 % ash and these values of proximate composition were similar to the observations of others, such as that of Kumar *et al.*, 1992.

During the conversion of 100 g soybean to 1 litre of soymilk, about 68.50 % total solids were recovered in soymilk and 23.00 % total solids were lost in okara, the remaining 8.8 % being the handling loss. The soymilk had 6.3 % total solids consisting of 3.3 % protein, 1.35 % fat, and 1.3 % carbohydrate. Several commercial preparations of soymilk have been reported to contain similar composition characteristics (De Man *et al.*,1987). Among the solids recovered during the conversion of soybean to soymilk, protein recovery was the highest, amounting to 86.2 % , followed by fat (71.40) and carbohydrate (46.55). In the process of converting soybean to soymilk, 8. 8 % of total solids were

Table 5.12 Gross composition and percentage recovery of soy-solids in the preparaion of muska

	Yield (g) per/100 g soybean		T S (%)	% Recovery	Protein (%)	% Recovery	Fat (%)	% Recovery	CHO (%)	% Recovery	Ash (%)	% Recovery
Soybean	100 g	Mean	92.00	-	38.30	-	18.90	-	29.00	-	5.75	-
		SD	1.06		0.35		1.07		1.38		0.08	
Soymilk	1000 ml	Mean	6.30	68.47	3.3	86.16	1.35	71.40	1.35	46.55	0.3	5.21
		SD	0.44		0.12		0.10		0.51		0.04	
Okara	190 g	Mean	11.00	22.70	2.4	11.90	2.3	23.12	4.10	26.86	2.2	72.70
		SD	1.08		0.36		0.45		1.91		0.2	
loss				- 8.83		- 1.94		- 5.48		- 26.59		- 22.0
Soymilk with added sugars (2 g in 100 ml)	1000 ml		8.25	-	3.3	-	1.35	-	3.3	-	0.3	-
Soy-muska	325 g	Mean	20.6	80.9	8.45	83.21	3.8	91.48	8.32	81.9	0.03	32.5
		SD	0.3		0.9		0.84		1.8		0.008	
Whey	650 ml	Mean	1.5	11.8	0.5	9.84	0.14	6.7	0.84	16.5	0.02	43.3
		SD	0.2		0.07		0.02		0.23		0.004	
loss				- 7.03		- 6.9		- 1.8		- 1.6		- 24.2

were lost due to the absorption of liquid by the filtering cloth, stickage in the utensils, equipments, and other similar handling loss which appears to be more for water soluble compounds such as ash (22 %, in the case of converting soybean to soy milk, and 24 % in the conversion of soymilk to soymuska).

The residue i.e. okara, retained after the filtration of soymilk, 2.4 % protein, 2.3 % fat and 4.1 % carbohydrate, indicating higher retention of carbohydrate (26.86) in okara compared to that of protein and fat (11.9 % and 23.12 % respectively). During the conversion of soybean to soymilk the fat to protein ratio has changed from 0.49 in soybean to 0.40 in soymilk and 0.96 in okara.

In the conversion of soymilk to soymuska only 1.5 % solids were lost in whey representing 0.5 % ,0.14, 0.84 % and 0.02 % protein, fat ,carbohydrate and ash respectively . The resultant muska retained 20.6 % solids with 8.45 % protein, 3.8 % fat , 8.32 % carbohydrate and 0.03 % of ash. The recovery of protein was slightly lower (83.2 %) compared to the recovery of fat (91.48) but was higher than the recovery of carbohydrates (81.9).In the conversion of soymilk to soymuska, fat to protein ratio has changed from 0.40 to 0.45. In the preparation of soymuska, hadling losses were mainly due to the absorption and sticking of material on the cloth and utensils, resulting in a loss of 7 % of total solids.

5.3.2 Gross compositional characteristics of cheese cakes

Cheese cake mix was prepared by mixing equal portions of soymuska and sugar. To the resultant slurry, thickening

ingredients such as egg, rice, wheat and potato paste were added at 20 % level, and baked using time - temperature combinations established for different products. The gross composition of cheese cakes are presented in Table 5.13.

Table 5.13 Gross composition, Titratable Acidity (TA), pH of standardized cheese cakes

Thickening Agent		Gross Composition of cheesecake*						
		Moisture (g)	Protein (g)	Fat (g)	Carbohydrates (g)	Ash (g)	TA % l.a.	pH
Egg	Mean	55.30	6.75	1.50	36.2	0.25	0.73	4.66
	SD	0.11	0.16	0.23	0.5	0.02	0.03	0.06
Rice	Mean	51.84	4.00	0.9	42.9	0.36	0.79	4.47
	SD	0.11	0.16	0.1	2.0	0.03	0.05	0.04
Wheat	Mean	53.08	4.69	0.85	40.96	0.42	0.85	4.29
	SD	1.12	0.15	0.04	1.06	0.03	0.03	0.04
Potato	Mean	52.32	4.73	0.75	41.81	0.38	0.1	4.40
	SD	0.44	0.06	0.08	0.61	0.03	0.04	0.03

As can be seen from Table 5.13 the standardized cheese cakes prepared with egg had a total solids content of 44.7 % and expectedly, higher levels of protein and fat, which were 6.75 % and 1.5 % respectively with 36.2 % carbohydrate. Cheese cakes prepared with rice, wheat and potato were composed of a lower level of protein and fat ranging from 4.00-4.73 and 0.75 -0.9 % respectively,and with a higher carbohydrate content of 41-43 % .

Eventhough, different varieties of milk based cheese cakes are prepared with varying amounts of cheese, cream and other ingredients, a typical composition of milk based cheese cake as reported by Smith and Siebenmann (1960) contained 6 gms. of protein , 32 grams of carbohydrate and much higher levels of fat i.e. 20 gms. compared to 0.7 - 1.5 gms of fat of the soybased cheesecake prepared in our study. The titratable acidity of the final products ranged between 0.7 - 1 % l.a. with a pH of of 4.2 - 4.6.

5.3.3 Storage and shelf-life characteristics of cheese cake

Among the standardized products with different thickening agents prepared with the addition of various flavour concentrates, such as cardamom , orange ,pineapple and mango, which had obtained the scores of above 4 (i.e liked very much) upon sensory evaluation,cheese cakes prepared with orange flavour was selected for storage studies under refrigeration temperature (4-10^{o}C) for the duration of 3 months (90 days). The seonsory evaluation of these products were carried out on 0, 15, 30, 45, 60, 75, and 90th day of storage. If a sample was found to be spoiled during the sensory evaluation, storage was terminated and the sample was examined microbiologically. If spoilage was not detected during the 15 day intervals of sensory evaluation

the storage was terminated at the end of 90 days and the samples were subjected to microbiological analysis.

Results of sensory evaluation of cheese cakes stored at refrigeration temperature (4-10^{o}C) for the duration of 0-3 months are presented in Table 5.14, (data detailed in Ap. no. 9.23). Sensory scores of cheese cakes prepared with egg, rice,wheat and potato stored under refrigeration (4 - 10^{o}C) temperature showed no significant difference between the 0 day and subsequent interval scores, interms of their colour & appearance, body & texture , flavour and overall acceptability. Mean scores for overall acceptability were above 4 indicating that all the products stored for 90 days (except in the case of egg and wheat products) were "liked very much". Eventhough the egg and wheat containing products scored slightly lower, these were not found to be significantly different from the others. The titratable acidity and pH of cheese cakes ranged between 0.7 - 1 % l.a. and 4.2 - 4.6 respectively and were not found to be altered on storage for the duration of 90 days at refrigeration temperature (4 - 10^{o}C).

Table 5.14 . Sensory characteristics of cheesecake on storage

Sensory Attributes	storage (days)						
	0	15	30	45	60	75	90
	Cheesecake containing Egg						
Colour & Appearance	4.7	4.3	4.3	4.4	4.3	4.3	4.2
Body & Texture	4.5	4.3	4.1	4.4	4.1	4.3	4.2
Flavour	4.2	4.3	3.9	4.2	4.4	4.3	4.0
Overall acceptability	4.3	4.2	3.9	4.1	4.3	4.2	3.9
	Cheesecake containing Rice						
Colour & Appearance	4.5	4.2	4.3	4.4	4.3	4.2	4.3
Body & Texture	4.5	4.3	4.3	4.3	4.3	4.2	4.4
Flavour	4.5	4.2	4.2	4.1	4.5	4.0	4.1
Overall acceptability	4.4	4.3	4.1	4.1	4.3	4.0	4.0
	Cheesecake containing wheat						
Colour & Appearance	4.3	4.1	4.0	3.8	4.1	4.5	4.3
Body & Texture	4.4	3.9	4.2	3.8	4.2	4.4	4.1
Flavour	4.3	4.2	4.1	4.1	4.3	4.2	4.2
Overall acceptability	4.3	4.1	4.0	4.1	4.1	4.1	4.0
	Cheesecake containing Potato						
Colour & Appearance	4.5	4.3	4.2	4.3	4.3	4.2	4.2
Body & Texture	4.3	4.1	4.0	4.0	4.1	4.2	4.1
Flavour	4.3	4.0	3.9	4.0	4.4	4.0	4.0
Overall acceptability	4.1	3.9	3.8	4.0	4.0	3.9	3.9

The microbiological analysis was carried out for the cheese cakes fresh and refrigerated products stored for 90 days at 4 - 10^{o}C , interms of Total Plate Count (TPC), coliform, yeast and mould, psychrophillic, and spore formers and the results are presented in Table - 5.15.

The microbiological analysis of cheese cakes on the 0 day of storage showed the Total Plate Counts of 100 - 266 / g for the products with four different thickening agents. The 0 day samples of wheat thickened cheese cakes had the lowest counts of 100 /g compared to the highest counts (266/g) in potato based cheese cakes. Total microbial counts of cheese cakes after 3 months storage showed increased count which ranged between 283/g for egg, 433/g for rice, 291/g for wheat and 291/g for potato containing cheese cakes.

A slight increase in Yeast and Mould counts were observed in all the four cheese cakes. The Yeast and mould counts of cheese cake after storage ranged from 66 - 150 /g compared to the counts of fresh cheese cakes which ranged between 16 - 83/g.

Coliforms were not detected in any of the cheese cakes before or after storage.

Table 5.15 Microbial count of cheesecake stored at $0^{o}C$- $4^{o}C$ for 3 months

Days of storage		Cheese cakes with Egg	Rice	wheat	potato
TPC (CFU/g)					
0 day	Mean	120	233	100	266
	SD	0.6	0.4	1.0	2.0
90 days	Mean	283	433	291	400
	SD	1.2	4.0	2.0	1.5
Yeast and mould					
0 day	Mean	47	50	16	83
	SD	0.2	0.01	0.28	1.1
90 days	Mean	150	66	116	150
	SD	0.5	0.3	0.5	0.3
Psychrophilic					
0 day		ND	ND	ND	ND
90 days	Mean	50	83	283	250
	SD	0.01	0.76	0.86	1.2
Total aerobic spore formers					
0 day	Mean	66	150	50	183
	SD	0.3	0.86	1.1	0.28
90 days	Mean	266	173	283	233
	SD	0.76	0.23	0.76	0.76
Titratable Acidity (% l.a.)					
0 day	Mean	0.75	0.81	0.83	0.91
	SD	0.04	0.05	0.03	0.04
90 days	Mean	0.81	0.80	0.89	0.95
	SD	0.05	0.07	0.09	0.03
pH					
0 day	Mean	4.58	4.50	4.46	4.46
	SD	0.06	0.04	0.04	0.04
90 days	Mean	4.55	4.46	4.36	4.44
	SD	0.02	0.04	0.09	0.1

ND : Not detected.
Note : Mean values represent the average of determinants.

Psychrophillic counts were observed after the storage period and the counts ranged between 50 -285/g in which potato thickened cheese cakes had the highest counts of 250/g.

The Sporeformer count was found to be increased in cheese cakes after storage. The initial counts ranged between 50 - 183 /g and increased to the level of 170 - 300/g . Highest count of sporeformers were observed with potato thickened cheese cakes before and after storage. The increase in sporeformer and yeast and mould count showed significant correlation ($p < 0.05$) with the increase in the total plate count in all the four products.