DISCUSSION

VI. DISCUSSION

The present study was undertaken to develop cured soy cheese spreads of satisfactory quality, utilising both soy slurry, and soy maska approaches. All the three spreads developed (two dependent on cheese, and one on milk solids) were mild cheesy in flavour. These products can form a low cost alternative to regular milk based cheese spreads. The foremost advantage of slurry, and blend approach to soy based cured spread is relatively simple way of accelerating flavour development in 8 to 10 days as against months required in conventionally cured cheeses. This in turn is likely to result in savings in manufacturing cost. Cheeses during the curing process undergo extensive changes in flavour, body and texture, as a result of several biochemical reactions initiated largely by the microbial enzymes. Utilising the bean in the form of cured cheese spreads rendered the product completely free from the typical beany flavour which made many dairy product analogues prepared from soybean unacceptable to the Indians.

In this study, soy maskas, and soy slurries were utilised as basic raw materials for the development of cheese spreads. Both involved heat treatments, wherein several anti-nutritional components such as trypsin inhibitors, and enzymes such as lipoxgyenase which are responsible for causing beany flavour in soy products are inactivated.

Since our approach was to utilise the whole soybean, it was essential to establish the conditions of preparing the soy milk for maska, to ensure optimum recovery of the soy solids resulting in the satisfactory cheese spreads. Within the range of bean concentration studied (100 to 200 g bean/L water), both the yield of soy solids, and its different constituents varied in the resultant milks, affecting in turn the curd strength, and maska yield. Although experiments conducted at the laboratory scale indicated 200 g soybean per liter water as the most desirable bean to water ratio, this is likely to change under industrial conditions, utilising different types of grinding, blending, or filtering devices. It is therefore, essential that the optimum bean to water ratio be established under actual manufacturing conditions with particular reference to overall yield of maska on dry matter basis, and its quality.

As expected, the acidity development needed for the formation of curd, and also in subsequent stages of maska, and cheese making was found to be influenced by the total solid levels of soymilks, and the type of carbohydrates available for fermentation by the starter culture. The soymilk with higher solids level attained the desirable acidity much earlier than the soymilks with lower solids levels. Sugar fortification of soybean milks at 1% level has been recommended due to its being deficient in fermentable sugars. Since, the lactic cultures were used in our study, lactose fortification understandably performed better than glucose, and sucrose. Similarly, the addition of milk solids (5% RSM), further enhanced the acid production.

A desirable curd for making maska should have proper firmness, and whey expulsion properties without causing an excessive loss of total solids in whey. While raising the solids level in soymilk (5.5 to 8.5% total solids) increased the curd firmness, added calcium ions caused immediate precipitation of a small portion of milk (presumably proteins), and lowered the curd firmness. It may therefore be necessary to conduct further studies for establishing the conditions under which the addition of calcium ions could improve curd firmness as reported in milk 9systems (Kikuchi et al., 1968).

The desirable flavour development in soycheese spreads were dependent on several factors particularly, the amount of cheese solids/milk solids blended, addition of culture, and additives such as papain, and GSH, pH control, agitation, and curing time, and temperature.

It is a well recognised fact that cheese flavour cannot be obtained without the use of lactic culture. This appears to be true also for soybean based cheese spreads. Soy cheeses, (Hang and Jackson, 1967) and soy slurries spread (Kumari and Singh, 1985) obtained by lactic fermentation were superior in flavour, body and texture. The dairy culture, used in our study, contributed significantly to the desirable flavour development compared to the sample which was bland with slight uncharacteristic flavour without culture.

Several specific cultures have been utilised in traditionally soy based products such as **Rhizopus oligosprorus** in tempeh, and **Pedioccus soyae (P. cerevisiae)** or **Saccharomyces rouxii** or **L. delbruckii** in soy sauces. However, no such attempts have been made in the present study to utilise any soy-specific culture. It is worthwhile to explore the possibilities of using such cultures in the development of soy cheese spreads.

It is pertinent to mention here that proteolytic, and lipolytic counts estimated on soy based media (soymilk and soy oil respectively), indicated lower growth during the initial days of curing. However, by 8 days of curing, the higher scores observed in soy media indicated that lactic micro-organisms might had adjusted to the soy-media as much as it is used to the milk based medium.

Daily agitation, seems to be important for soy based slurries during the curing. The undisturbed samples were characterised by unclean, sharp ammonia type putrid flavour. On the contrary, for the maska blends, even occasional agitation was found to be adequate. Essentiality of agitation in the flavour development of slurry based cheeses has been assoicated with their importance in Redox control (Kristoffersen and Gould, 1959; Davis et al, 1933).

Initial and daily adjustment of pH to 5.3 in soy slurries during ripening was found to be necessary for acceptable flavour development since pH is an important factor for the control of various enzymatic actvities. It has been reported that at a very low pH, the enzymes particularly proteolytic type get inactivated (Eck, 1987). A pH around 5.3 is reported to be more conducive to various enzymic activities, more particularly for the proteolytic enzymes. In soy slurries, there was a continuous decrease in pH resulting in pH levels, much lower than 5.3, largely due to lactic fermentation during the initial days of curing. It was thus necessary to adjust the pH to 5.3, on a daily basis. Changes in pH during the ripening of milk slurries (Singh and Kritoffersen, 1970) are considerably slower than that was observed for the soy slurries, possibly due to the lower buffering capacity of soy system (Kumari and Singh, 1985).

Consistent with the well documented role of the proteolytic enzyme, papain (Obara, 1968; Emmons _et al._, 1970; Green, 1972; Kumari and Singh, 1985), its addition to the soy slurries at 0.01% level was beneficial to the flavour development both in cheese, and milk solids containing systems. The profound effect of GSH on the flavour characters, and flavour intensity of soy slurries lend support to the findings of previous investigators (Kristoffersen _et al._, 1964, 1967), that active sulphydryl groups may be intimately associated with characteristic flavour development. Kumari and Singh (1985) corroborated these findings in their study where addition of 100 ppm GSH to the soy based slurries resulted in an increase in the formation of active -SH groups during warm curing (30oC). In the absence of papain and GSH, the product developed an uncharacteristic flavour.

For the development of flavour, the incubation period was found to be 8 to 10 days at 25 to 30oC (RT) in milk solids blended in slurries, 8 to 10oC (LT) in cheese blended maska samples, and alternating temperature of 3 days LT, 3 days RT, and 2 days LT in cheese blended slurry based samples. The alternative temperature sequences adopted in cheese blended slurry samples may not be ideal, and easily acceptable to the industry. The possibility of other combinations of curing time - temperature requires to be explored.

The acidic nature of the fresh maska changed gradually into a mild cheesy type during 8 to 10 days of curing (at 8 to 10oC) with occasional agitation. On the other hand, the flavour of fresh slurries was a blend of several sensations such as beany, pasty, acidic (due to addition of lactic culture). These gradually changed into a mild cheesy - bitter type. In general, the final products were devoid of any beany flavour, and with no manifestation of any kind of lingering after taste. While maska based samples could be cured for 3 to 4 weeks, terminating the incubation of slurry based samples within 8 to 10 days was critical as off- flavour development ensued very rapidly after that period.

The development of flavour, body, and texture in cured varieties of cheeses, depends on protein and lipid degradations, the extent of which is the characteristic of the cheesee variety. The soy based samples in the present study contained protein and lipid from both soybean and milk/cheese. The relative degradation of proteins and lipids from soy and milk/cheese was not examined in this study. In genereal, proteolysis was faster in slurry based samples than maska based ones. Similar pattern was apparent with respect to lipolytic changes.

Several processing alterations such as time, and temperature during curing, addition of several additives to enchance the flavour profile have been attempted in a limited way in the present study to give an acceptable flavour profile. More exhaustive studies may be needed to commercialize the product on a large scale.

The major objectives of this investigation have been to eliminate the beany flavour, and also to obtain a flavour profile, similar to cheddar cheese type, which is highly acceptable to Indian palate. All the three soy based cheese spreads developed in this study were free from beany flavour, and any unpleasant after taste. However, the spreads lacked an intense cheddar cheese type flavour, eventhough these were well accepted with flavour additives. This is largely due to the inherent differences between the milk and soybean systems.

Although soybased spreads were not compared with the milk based spreads available in the market, there were certain distinct differences between the two. The soybean based spreads had a unique colour, which were dependent on the bean varieties selected, and ranged from white to light brown, whereas milk based spreads in the absence of added colour would be white. The soy spreads of the present study were somewhat coarser, grainy in texture, since wet grinding in place of colloid mill was used in the preparation of slurries. Although the flavour of soy cheese products were well accepted as a distinct class of its own, they were not similar to entirely milk based cheeses.

Inspite of having several functional qualities similar to that of milk system, the composition of soybean is very different from the milk. Eventhough during curing the soybean systems were undergoing glycolysis, proteolysis, and lipolysis, as experienced by the milk systems, the rate, extent of these reactions, and resultant end products of these processes are not likely to be the same. Due to the differences between cow and buffalo milk systems, cheddar cheeses prepared from buffalo milk is not even recognised to be identical with the cow milk cheddar. The dissimilarities between soy and the milk system being wider, developing cheddar type flavour was less likely to be achieved.

The processed soy cheese spreads were able to keep satisfactorily for about three months under refrigeration without any particular care in terms of using special packaging materials or permissible preservative such as sorbic acid or its salts eg. potassium sorbate. No visual microbial growth was seen on the surface of the spreads. Improved commercial packaging system along with hermetic sealing is likely to boost shelf life further at industrial level.

It appears from our study that cheese dependent soy cheese spreads (both maska, and slurry based) were more acceptable compared to milk solids based ones from the point of sensory evaluation scores. Apart from scoring highest for flavour, and over all acceptability, the cheese blended slurry based spread had certain preparatory advantages over the maska based ones, which needed additional time and effort in curd making, and draining steps, and the burden of residue disposal. In contrast, the additional processing for slurry making is only the dehusking step at the bean level, which might be eliminated by proper processing alternatives at an industrial scale (such as freshly dehusked dals, or fresh-ground and dehusked soy flour).

On the basis of raw materials costs alone, the slurry based cheese blend had the advantage of maximum yield (720 g spread / 200 g bean), and low cost (Rs. 2.44/- per 100 g) compared to maska based cheese blends (580 g spread / 200 g bean, and Rs.5.34/- per 100 g).

Under the Indian context, where spreads are becoming more popular, and milk based cheese spreads being expensive, the soy cheese spreads seem to be a satisfactory alternative. This study has established satisfactory methods of manufacturing soybean spreads by both slurry, and maska approaches. Further indepth studies are required to be taken up at industrial levels.