SUMMARY

6.0 Attention has been drawn to the importance of buffalo as a major contributor towards milk production in areas of South East and Middle East Asia like Pakistan, India, Thailand, Burma, Phillipines etc. The average milk production of a buffalo in India is more than half of the total milk produced. Among the dairy products, butter is the most popular one, not only in the developed countries but also in developing countries. Many investigators have indicated that changes in the composition of milk fat are responsible for the majority of variations in the physical characteristics of butter. Since butterfat from buffalo milk differs considerably in chemical composition from that of cow milk, the physico-chemical properties of butter made from buffalo milk differ considerably from that of butter from cow milk. The present study was undertaken to assess (1) the factors influencing the spreadability of table butter from buffalo milk especially the influence of different regional effects (such as feeds) (2) the methods for improving spreadability by use of low melting triglycerides, surface active agents, butter with low fat and spray dried butter from buffalo milk.

6.1 A comprehensive review of literature on the subject
spreadability of butter has been made and included in the thesis to bring out the present status of knowledge on the following aspects:

6.1.1 Spreadability of butter.
6.1.2 Objective measurements.
6.1.3 Relationship between structure and rheological behaviour.
6.1.4 Factors affecting butter spreadability.
6.1.5 Fractionation of butterfat.
6.1.6 Modification of butterfat
6.1.7 Use of surface active agents.
6.1.8 Low calorie butter and spread.
6.1.9 Dry Butter.

Wherever essential information abstracted from literature is suitably commented upon to indicate the significance of the contribution.

6.2 The scope of the work is laid out as collected information on rheological properties of buffalo butter, arising out of seasonal and regional variations and improvement of the same characteristics. The work was, therefore, planned to study the

6.2.1 effect of regions and seasons on different rheological parameters of table butter made from buffalo milk.
6.2.2 Use of low melting triglycerides, surface active agents and different levels of fat contents on different rheological parameters of table butter made from buffalo milk.
6.2.3 Standardising the method of manufacture of spray dried butter powder from buffalo milk and study of different rheological properties of recombined butter made therefrom.

6.3. The experimental procedures adopted in the studies such as collection of buffalo cream from different regions during different seasons, preparation and packaging of butter, use of low melting triglycerides and surface active agents in preparation of butter; butter with low fat and spray dried butter powder as well as the procedure for reconstitution of butter powder are described in experimental section with appropriate modifications (if any). The description of analytical procedure adopted for the estimation of physico-chemical constants like penetration value, yieldstress, viscosity, "oiling off" refractive index, melting point, iodine value, Reichert-Meissl, Polenske value and saponification value as well as shortchain and longchain triglycerides and fatty-acid composition of butterfat of various samples are also given in the experimental section.

6.4 The results indicated that

6.4.1 The refractive index in Winter and Summer was observed to be maximum in the Western region (1.4555 and 1.4559) followed by the Mid-western (1.4537 and 1.4559), South-eastern (1.4543 and 1.4552) and North-Western (1.4545 and 1.4549) regions.

6.4.2 The melting point in winter and summer was observed to be maximum in the South-eastern region (38.90 and 38.70) followed by the Mid-western (38.25 and 37.45), Western (36.85
and 36.30) and North-western (35.40 and 34.75) regions.

6.4.3 The average viscosity (poise) was observed to be maximum in the Mid-western region (50.65) and lowest in the Western region (38.2) in the winter season, whereas in the summer season it was observed to be maximum in North-western region (44.70) and lowest in the Western region (27.375).

6.4.4 The average penetration value (0.1mm/mm) in the winter season was observed to be maximum in the Western region (92.75) followed by the North-western (90.5), Mid-western (84.25) and South-eastern (78.5) regions, whereas in the summer it was observed to be maximum in the North-western region (94.50) followed by the Western (94.25), Mid-western (99.25) and South-eastern regions.

6.4.5 The average yieldstresses (dynes/cm²) in the winter and summer seasons were observed to be maximum in the Mid-western region (957.95 and 684.50) followed by the South-eastern (795.15 and 633.20), North-western (603.25 and 506.0) and the Western (527.75 and 457.75) regions.

6.4.6 The average "oiling off" (gms) in the winter season was observed to be maximum in the North-western region (8.5251) followed by the South-eastern (7.1620), Mid-western (7.1343) and Western (7.0878) regions whereas in the summer it was observed to be maximum in the North-western (8.6430), followed by Mid-western region (7.7040) South-eastern region (7.5795) and Western region (7.2090).

6.4.7 The average Reichert-Meissl value in the winter was
observed to be maximum in the North-western region (32.43) followed by the Mid-western (30.95), South-eastern (30.90) and Western (29.15) regions, whereas in the summer season it was observed to be maximum in Mid-western (30.63) followed by the North-western (29.90), South-eastern (28.95) and Western (27.65) regions.

6.4.8 The average polenske value in the winter season was observed to be maximum in the Mid-western (1.925), followed by the North-western (1.90), Western (1.575) and South-eastern region (1.40) whereas in the summer season, it was observed to be maximum in the Mid-western (1.525), followed by the North-western (1.35), South-eastern (1.125) and Western (1.15) regions.

6.4.9 The average saponification value in the winter season was observed to be maximum in the South-eastern region (242.35) followed by the North-western (236.90), Mid-western (231.15) and Western (226.15) regions whereas in the summer season, it was observed to be maximum in the South-eastern region (236.35) followed by Mid-western (228.90), North-western (228.50) and western (213.20) regions.

6.4.10 The average iodine values in the winter and summer season were observed to be maximum in the Western region (30.10 and 30.50) followed by the North-western (27.90 and 29.30), Mid-western (26.55 and 23.15) and South-eastern (25.55 and 25.45) regions.

6.4.11 The average spreadability scores in the winter and summer were observed to be maximum in the Mid-western region (5.1666 and 4.3333) followed by the South-eastern (4.000 and 3.1666), North-western (3.50 and 3.1666) and Western (3.1666...
5.4.12 The refractive index, penetration value, "oiling off" and Iodine values were observed to be higher in summer season as compared to the winter season whereas the melting point, viscosity, yield stress, Reichert Weissl value, polenske value, saponification value and spreadability scores were observed to be higher in the winter as compared to the summer season in all the regions.

6.4.13 The average value for longchain and short chain triglycerides ranged from 58.33 to 61.60% and 38.37 to 41.47% respectively during the winter season whereas in the summer they ranged from 56.75 to 59.33% and 40.67 to 43.24% respectively in all the regions. The percentages of longchain triglycerides were higher in winter season as compared to the summer season in all the regions. In the winter season maximum percentage of longchain triglycerides were recorded for samples from the Mid-western region followed by samples from South-eastern, Western and North-western regions. In the summer season maximum longchain triglycerides were recorded in samples from South-eastern region followed by those from Western, Mid-western and North-western regions.

6.4.14 The fatty acids of butterfat collected from different regions during different seasons varied significantly. The major fatty acids like butyric, myristic, palmitic, stearic and oleic acids accounted towards a major part of the composition of triglycerides from buffalo milk collected from different regions during different seasons of the year.
6.4.15 The effect of adding low melting triglycerides to cream on the physico-chemical properties of butter made therefrom were studied. Properties like penetration value, "oiling off", saponification values increased proportionately whereas melting point and yield stress decreased proportionately with the addition of low melting triglycerides. In buffalo butter (to which low melting triglycerides were added at different levels) it was observed that linear relationship existed between the refractive index, melting point penetration values, yield stress, "oiling off", saponification value and iodine values whereas quadric relationship existed between viscosity, Reichert Meissl value and spreadability score.

6.4.16 The effect of addition of surface active agents to buffalo cream was also recorded. The addition of surface active agents (particularly lecithin at 1% level) was found to increase the penetration value (0.1mm/mm) substantially from 91.70 to 95.15. The addition of surface active agents (Tween-60 and lecithin) were found to reduce the yield stress and viscosity from 854.18 to 598.58 dynes/cm² and 48.96 to 46.10 poise respectively. It was concluded that Tween-60 was less effective compared to lecithin.

6.4.17 The effect of the fat contents of butter made from buffalo cream on the physico chemical properties were ascertained. It was observed that penetration values decreased with increased in the fat contents of butter whereas viscosity, yield stress and spreadability score got reduced with the increase in fat contents.
Linear relationships could be established between penetration value, yield stress, viscosity and fat contents in the corresponding butter samples.

6.4.13. A method has been standardised for the production of dried butter from buffalo milk. The composition of the product was determined to correspond to fat 80.54% and moisture 1.53%. This product has subsequently been used for the preparation of reconstituted butter. Simultaneously, the physical characteristics such as yield stress, viscosity, penetration value and spreadability score of the reconstituted product was also determined. The yield stress (dynes/cm²) varied from 680.5 to 819.0, viscosity (poise) ranged from 27.5 to 31.2 and penetration value (0.1mm/mm) ranged from 95.5 to 99.0. The spreadability score ranged from 2.666 to 3.00. It was, therefore, concluded that the physical characteristics of the reconstituted butter from buffalo milk can be improved by spray drying process following the procedure developed in the present studies. However, the overall consistency of the reconstituted butter could not be declared to be identical with that of normal butter.