5. SUMMARY

The problem as envisaged in this investigation was to provide a low cost, yet nutritive weaning food for children, aged 1-4 years, from low income families. For this, two basic raw materials which were inexpensively available locally, i.e. soybean and cheese whey were used. It was also considered that the equipment already available in a dairy plant should be useable and the capital investment
for new or additional equipment should be low to minimise the cost of manufacture.

It is a well known fact that soybean, a legume, is a rich source of proteins and oil rich in polyunsaturated fatty acids. However the presence of antinutritional factors, such as trypsin inhibitor and production of off-flavour due to lipoxidase in raw soybean have been deterrent in its utilization. Cheese whey on the other hand is a dairy byproduct. Since its utilization has been quite expensive, it is usually discarded or at most used as cattle feed. It creates a problematic situation on dumping into sewerage system because of its high BOD. Cheese whey produced during cheese manufacture contains milk solids other than casein and fat. Therefore, it is rich in lactose, whey proteins, minerals and water soluble vitamins. Since buffalo milk is primarily handled by the organised sector, for the manufacture of milk and milk products, it was considered necessary to use buffalo-milk Cheddar cheese whey for this investigation.

In order to increase the nutritional value of soybean, methods of processing were included that would destroy the antinutritional factors and lipoxidase (to prevent off-flavour development).
Nutritive value was estimated in terms of PER, after selected steps of processing, admixing with cheese whey, and fortification with vitamins and iron, and DL-methionine. On the basis of different parameters studied such as solubility index and homogenisation pressure, a process was standardized for the manufacture of soy whey weaning food (SUUF) on a plant scale.

The shelf life of the product in tin containers or polythene bags, at room or refrigerated temperature was studied for a period of 12 months in terms of physico-chemical characteristics. The effect of 12 month storage on the PER value of the SUUF was also estimated. Moreover the SUUF, flavoured and unflavoured, was tested for its acceptability after storage in tin containers (under nitrogen) at 5°C±2°C and 30°C±1°C, and unflavoured SUUF for peroxide value, available lysine, solubility index and soluble nitrogen, too.

Further, in an independent study at Punjab Agricultural University, Ludhiana (Hansra, 1977) the product was subjected to nutritional assessment with respect to its PER and true digestibility, and tested as a supplementary diet for pre-school children.

The cost of production of the SUUF in terms of raw material and processing were determined.
The results obtained in the course of the present investigations are summarized below:

1. Buffalo milk Cheddar cheese whey was analysed and found to contain on an average 0.936 percent crude protein, 0.380 percent fat, 4.940 percent lactose and 0.616 percent ash.

2. Soybean consisted of 88.83 percent cotyledons, 8.73 percent hulls and 2.44 percent plumules. Whole soybean had a composition of 42.13 percent crude protein, 31.31 percent carbohydrates, 21.24 percent fat and 5.32 percent ash. It was further observed that 24.34 percent of the dry matter present in whole soybean was lost either during processing due to leaching or discarded as hulls and plumules. Therefore, 75.66 percent of the whole soybean was used for the manufacture of SWUF.

3. On the basis of the solubility index requirement of the ISI for an infant food based on vegetable proteins, a ratio of 35 percent soy solids to 65 percent whey solids was found to be optimum.

4. In order that the weaning food contained the requisite quantity of fat, the process required an additional source of fat. This could be a refined oil but in its absence a hydrogenated
vegetable oil was used as permitted by Protein-Calorie Advisory group of the United Nations.

5. In order that the food contained adequate quantity of vitamins, and minerals, the soy-whey powder was fortified with a vitamin mixture and iron. Since the weaning food as standardised in this investigation contained adequate quantities of all the essential amino acids, except methionine, the level of this amino acid was raised to the nutritionally desired level by enrichment with DL-methionine.

6. During the study of the method of processing, it was observed that the PER (values corrected to casein at 2.50) of raw soybean was only 0.14. Upon presoaking overnight in 0.5 percent sodium bicarbonate and blanching for 30 minutes in fresh boiling water, the PER rose to 2.06. When soybean was admixed with whey (in ratio of 35:65 on solids basis), the PER further rose to 2.28. Maximum increase in PER was observed when the soy-whey powder was enriched with methionine; the PER jumped to 3.24. Thus, it was established that it is possible to increase the PER of soybean by heat processing, enrichment with whey and fortification with methionine.
7. The process for the manufacture of SUUF as standardised in this investigation requires that food grade soybean are dry cleaned; split, undersized, wrinkled and damaged beans should be removed, and the soybean soaked in 10 volumes of water, containing 0.5 percent sodium bicarbonate, for 12 hours. The soak water should be discarded and soybean blanched in fresh boiling water for 30 minutes. The blanched soybean should be cooled with tap water, dehulled to remove hulls as well as plumules and the cotyledons disintegrated with cheese whey to pass through a 325 mesh screen. The soy-whey mixture is required to be preheated to 98°C, condensed to 35 percent solids, enriched with oil and fat-soluble vitamins and homogenized in a two stage homogenizer while maintaining a pressure of 3000 psi in first stage and 500 psi in the second before spray drying, after addition of ferrous sulphate, with an inlet temperature of 190°C and outlet temperature of 95°C. The powder so obtained is to be fortified with water soluble vitamins, DL-methionine and (encapsulated) flavour. The SUUF can then be packaged in polythene bags or tin containers.
When the data on the physico-chemical properties of SWUF during storage (air packed) were analysed, it was observed that:

a) the moisture content tended to increase in the polythene bags, the increase being higher at higher storage temperature, whereas showed no appreciable change in tin containers;

b) the non-protein nitrogen content increased in both polythene bags and tin containers, the increase being more rapid in the former and at higher temperature;

c) while there was decrease in the soluble nitrogen content of the product in both the types of packaging materials, it was substantially higher at 30°±1°C.

d) the free-fat content of the stored samples rose in all the cases, the rise being materially higher in polythene bags at 30°±1°C unlike other samples;

e) the SWUF increased in its free-fatty acids content with the storage time, the increase was faster in polythene bags than in tin containers at 5°±2°C and it was still faster at 30°±1°C in polythene bags;

f) the product suffered losses in the available lysine content during the storage in all
cases, however, the loss was minimal in tin containers at 5\(^\circ\)C and maximal in polythene bags at 30\(^\circ\)C;

g) the peroxide value of the SUUF increased in all cases and the increase was highest in polythene bags at 30\(^\circ\)C and lowest in tin containers at 5\(^\circ\)C;

h) whereas the SUUF stored in tin containers at 5\(^\circ\)C underwent no colour change and that in tin containers at 30\(^\circ\)C showed a slight discoloration, the product in polythene bags at 5\(^\circ\)C as well as 30\(^\circ\)C showed considerable discoloration;

i) the solubility index of the stored SUUF showed a tendency to increase, the increase being highest in polythene bags at 30\(^\circ\)C and yet below the objectionable level (15 ml assumed to correspond to 85.0 percent solubility);

j) whereas the wettabillity of the SUUF packaged in polythene bags at 5\(^\circ\)C, tin containers at 5\(^\circ\)C and 30\(^\circ\)C decreased during storage, that in the case of polythene bags at 30\(^\circ\)C increased considerably; this could probably be due significant water absorption in the last case;

k) the dispersibility of SUUF fell gradually during the storage and the fall being maximum in the case of polythene bags at 30\(^\circ\)C;
while the SWW stored at 50\textdegree\pm20\textdegree C showed no appreciable change in the viscosity on reconstitution, those stored at 300\textdegree\pm10\textdegree C showed some increase; the bulk density of the product showed almost no drop in case of tin containers at 50\textdegree\pm20\textdegree C, a slight drop in tin containers at 300\textdegree\pm10\textdegree C, a marked drop in the case of polythene bags at 50\textdegree\pm20\textdegree C and significant drop in polythene bags at 300\textdegree\pm10\textdegree C; this could be attributed to the proportionate rise in moisture content during storage in respective samples; storage of the SWW in tin containers resulted in no perceptible change in the average particle density whereas that in polythene bags resulted in noticeable reduction; of all the samples kept in the storage, only the one in polythene bags at 300\textdegree\pm10\textdegree C showed a considerable decrease in the percent volume occupied by the powder particle.

It was further concluded that the product could not be stored for more than 6 months (on account of increase in MPN) in polythene bags at 50\textdegree\pm20\textdegree C and tin containers at 300\textdegree\pm10\textdegree C, 2 months (on account of decrease in dispersibility) in polythene bags at 300\textdegree\pm10\textdegree C and 8 months (on account of increase in MPN) in tin containers at 50\textdegree\pm20\textdegree C.
9. Shelf life studies conducted on SWUF in tin containers (nitrogen packed) at $5^\circ\pm2^\circ\text{C}$ and $30^\circ\pm1^\circ\text{C}$ did not show significant changes in peroxide value, available lysine, solubility index and soluble nitrogen, over a 12 month storage period.

On comparison of flavour preferences among strawberry, vanilla and pineapple and unflavoured control, the panel of judges preferred strawberry most followed by vanilla, pineapple and unflavoured control, in fresh and stored samples.

On the basis of flavour scores, during storage it was found that the SWUF flavoured with strawberry, vanilla and pineapple, and unflavoured control could be stored for not more than 12, 12, 12 and 8 months respectively at $5^\circ\pm2^\circ\text{C}$ and 12, 9, 5 and 4 months respectively at $30^\circ\pm1^\circ\text{C}$.

10. Studies on the nutritional aspects of the stored SWUF revealed that the PER (corrected to casein at 2.50) reduced to 2.36 for both polythene bags and tin containers at $5^\circ\pm2^\circ\text{C}$, and to 1.62 and 2.12 respectively for polythene bags and tin containers at $30^\circ\pm1^\circ\text{C}$. 
11. Estimates on the costs of raw materials (Rs. 2.98) and processing (Rs. 1.88) (excluding packaging) indicated that the finished product would cost Rs. 4.86 per kg at a production rate of 1,55,000 kg per year.

12. When the soy whey weaning food was independently assessed Department of Food and Nutrition, Punjab Agricultural University, Ludhiana for its nutritional status, it was found to have a PER of 3.23, near identical to that found in this investigation (3.24). The SWWF was also found to have a reasonably good true digestibility (86.0 percent as compared to 94.9 percent for skim milk powder), and excellent value as a supplementary diet for pre-school children. The investigator emphasized the need for popularizing such a low-cost product for improving the health of the children from low-income families.