Appendix
PRODUCTION AND ANALYSIS OF LOW COST ACIDO-WHEY BEVERAGE

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Introduction

Whey is one of the most important by-products of the dairy industry, obtained from paneer, chenna and casein making. In India, cheese manufacturing is in an expanding stage. Three million tonnes of whey are produced annually in India containing about 0.2 million tonnes of valuable milk nutrients. However, their use has not yet been appropriately commercialized. Whey contains about 6 to 7 per cent of total solids comprising of approximately 70 per cent of lactose, 0.9 per cent of protein and trace amount of water soluble vitamins, minerals and fat. Whey can benefit those with a wide variety of health concerns ranging from the exceptionally healthy athlete to those trying to maintain lean muscle mass. It has quickly become the choice protein among compatible body builders. Whey is also fortified with L-Galantane, which is reported to trigger the release of growth hormone and forms building block for the body’s most important water soluble anti-oxidants viz. glutathione (GSH). Whey protein is nutritionally perfect having all the essential and non-essential amino acids. Whey is one of the best sources for high quality protein. It is also among the most powerful anti-aging, fat-burning, disease-fighting food. It has been surveyed that most of the whey is discarded because there is no sufficient use or need for it. The presence of high organic matter content in whey poses a serious problem in its disposal. Therefore, many dairy organizations treat the whey before disposal which is rather expensive. In this context, a study was conducted for the effective utilization of whey fortified with soya milk and developed a ready-to-use fermented whey beverage. Further, the sensory evaluation, keeping quality, consumer acceptability and economics of this beverage were also worked out.

Materials and Methods

Milk samples were collected from the University Dairy Farm and private vendors for the preparation of paneer. Lactobacillus acidophilus culture for the preparation of acido whey was obtained from the Dairy Microbiology section of the National Dairy Research Institute, Karnal. Soya milk was prepared by soaking and extraction of soya seeds. The standard quality, flavour and colour were procured from the local market.

Culture preparation

Culture was prepared by using 100 g of skimmed milk powder in one liter of distilled water and the inoculated culture was kept in incubator at 30°C for 24 hours. Then, it was stored at 4°C. The steps involved in preparing the acido-whey beverage is shown in Fig. 1.
Whey
↓
Heating (60 – 70°C)
↓
Fat separation
↓
Cooling (Room Temperature)
↓
Inoculation (Lactobacillus acidophilus)
↓
Incubation (39 ± 1°C; 20-24 hrs)
↓
Filtration
↓
Addition of soymilk
↓
Addition of sugar syrup (50%)
↓
Addition of flavour and colour
↓
Mixing
↓
Packing (Glass bottles)
↓
Storage (at 4°C)
↓
Distribution

Figure 1
Sequential steps involved in acido-whey beverage preparation

**Details of production**

Whey obtained from paneer production was heated at 60 to 70°C for 20 minutes to kill the microorganisms and to remove the fat. It is then cooled to 40°C and fed to incubation tank pre adjusted to the specified temperature (39°C). The cold heat treated whey was inoculated with 5 per cent (v/v) of Lactobacillus acidophilus culture. After completion of the fermentation, it was cooled and filtered through muslin cloth and soymilk was added at the ratios of 25 and 50. Sugar was added in the form of syrup (50%). This preparation was flavoured with the pineapple and orange essence at the required level. Trials were conducted to determine the best flavour and suitable combination of soya milk and fermented whey. The evaluation was based on the sensory evaluation. For keeping quality analysis the samples were kept at 4°C in the refrigerator.

**Sensory evaluation**

Sensory evaluation of acido-whey beverage was carried out using a 9 point hedonic rating scale. Flavour, taste, colour, appearance, texture and overall acceptability of acido-whey drinks were determined before and during storage using the hedonic scale.

**Chemical analysis**

The developed acido-whey beverage was analyzed for fat (Gerber method), protein (Pyne’s method), lactose (Lane Eynon method) and acidity by titration detailed in IS: SP (1981).

**Bacteriological analysis**

The samples of acido-whey beverage were subjected to microbiological test like
standard plate count for the detection of yeast and mould count by using the standard procedures.

**Results and Discussion**

**Sensory evaluation**

The average results of sensory evaluation of different acido-whey drinks are listed in Table I. According to the results, sample $S_1$ (75% whey + 25% soy milk) showed the high percentage of overall acceptability, whereas sample $S_2$ (50% whey + 50% soy milk) showed low acceptability. The sensory attributes of the two samples deteriorated after ten days of storage. Prasad et al. reported that the sensory flavour and overall acceptability scores varied from 6.23 to 7.95 per cent in the case of whey based mango beverages in different combinations of sugar and whey. In order to increase the beneficial effect of soya consumption, soya extract was blended with flavoured beverages with low anti-nutrient content.

**Quality parameters**

The quality parameters such as fat, protein, lactose and acidity of different acido-whey drinks were determined and the average results are presented in Table II. The fat percentage of samples $S_1$ and $S_2$ showed no change at different storage period. But, between the samples there was variation in their fat percentage ($S_1$: 0.7% and $S_2$: 1.2%) which was due to the addition of different proportion of soy milk. Between the two samples, sample $S_2$ recorded the high percentage of fat as it contained high portion of soy milk (i.e., 50 parts of soy milk and 50 parts whey) and sample $S_1$ had low fat percentage due to the high proportion of whey. Both the samples showed variation in their protein percentage ($S_1$: 1.26%; $S_2$: 1.56%) and sample $S_2$ had higher protein percentage because it contains 50 per cent soymilk. Storage temperature and period had no effect on the protein content of the samples.

**TABLE I**

<table>
<thead>
<tr>
<th>Sampling day</th>
<th>Samples</th>
<th>Colour and appearance</th>
<th>Flavour</th>
<th>Taste</th>
<th>Texture</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Day</td>
<td>$S_1$</td>
<td>85</td>
<td>78</td>
<td>80</td>
<td>78</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>$S_2$</td>
<td>80</td>
<td>71</td>
<td>72</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt; Day</td>
<td>$S_1$</td>
<td>72</td>
<td>68</td>
<td>65</td>
<td>70</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>$S_2$</td>
<td>70</td>
<td>63</td>
<td>60</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>10&lt;sup&gt;th&lt;/sup&gt; Day</td>
<td>$S_1$</td>
<td>52</td>
<td>43</td>
<td>38</td>
<td>40</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>$S_2$</td>
<td>46</td>
<td>35</td>
<td>30</td>
<td>30</td>
<td>32</td>
</tr>
</tbody>
</table>

$S_1$: 75% whey + 25% soy milk;  $S_2$: 50% whey + 50% soy milk

5<sup>th</sup> and 10<sup>th</sup> day the samples were stored at 4°C.
PRODUCTION AND ANALYSIS OF LOW COST ACIDO-WHEY BEVERAGE

TABLE II
Quality Parameters of Acido-Whey Beverage

<table>
<thead>
<tr>
<th>Sampling day</th>
<th>Samples</th>
<th>Fat (%)</th>
<th>Acidity (%)</th>
<th>Protein (%)</th>
<th>Lactose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(^{st}) Day</td>
<td>(S_1)</td>
<td>0.7</td>
<td>0.24</td>
<td>1.3</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>(S_2)</td>
<td>1.2</td>
<td>0.22</td>
<td>1.6</td>
<td>2.8</td>
</tr>
<tr>
<td>5(^{th}) Day</td>
<td>(S_1)</td>
<td>0.7</td>
<td>0.24</td>
<td>1.3</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>(S_2)</td>
<td>1.2</td>
<td>0.22</td>
<td>1.6</td>
<td>2.8</td>
</tr>
<tr>
<td>10(^{th}) Day</td>
<td>(S_1)</td>
<td>0.7</td>
<td>0.27</td>
<td>1.3</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>(S_2)</td>
<td>1.2</td>
<td>0.23</td>
<td>1.6</td>
<td>2.8</td>
</tr>
</tbody>
</table>

\(S_1\) – 75% whey + 25% soy milk; \(S_2\) – 50% whey + 50% soy milk

5\(^{th}\) and 10\(^{th}\) day the samples were stored at 4\(^{\circ}\)C.

Both samples showed variations in their lactose percentage (\(S_1\)-4.38%; \(S_2\)-2.76%). The sample \(S_1\) had high lactose percentage because it contained 75 per cent whey. Storage period had no effect on the lactose content of the samples. According to the result presented in Table II, there was no increase in the acidity during 1\(^{st}\) and 5\(^{th}\) day of storage. After 10 days of storage, there was an increase in the acidity level. Examination of data in Table II indicated that sample \(S_1\) showed low acidity (0.232%) whereas sample \(S_2\) showed high acidity (0.272%). Low acidity in sample \(S_2\) was due to high proportion of soya milk and less proportion of whey.

Microbial analysis

The average results of microbial analysis are presented in Table III. The results showed that sample \(S_1\) having higher bacterial count than the sample \(S_2\). Regarding the yeast and mould count, the result indicated that sample \(S_1\) had higher count than sample \(S_2\).

The cost of production of acido-whey drink (per liter basis) was worked out and presented in Table IV. The results indicated that preparation of cost per liter of acido-whey drink for the combination of whey and soy milk is 75 : 25 was Rs.14.75. The cost of production was Rs. 15.50 for the acido-whey drink with the 50 : 50 combination. In this

TABLE III
Microbial Analysis of Acido-Whey Beverages

<table>
<thead>
<tr>
<th>Sample</th>
<th>SPC ((10^4))</th>
<th>Yeast ((10^4))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1(^{st}) day</td>
<td>5(^{th}) day</td>
</tr>
<tr>
<td>(S_1)</td>
<td>50</td>
<td>52</td>
</tr>
<tr>
<td>(S_2)</td>
<td>44</td>
<td>46</td>
</tr>
</tbody>
</table>

SPC- Standard Plate Count
calculation, the cost of whey was not included as it was available as waste during paneer and cheese production. The cost of bacterial culture is also very meager. In the market, there are various types of soft drinks available, but the cost is comparatively higher. The soft drinks are added with heavy concentration of preservatives and filled with carbonated gases posing health problem to the consumers.

Summary and Conclusion

The fermented acido-whey drink was found to be a very nutritious drink for the health and this can be a benefit to all type of people especially for the athletes. Since this acido-whey product was prepared with soy milk, which is the most economic source of dietary protein in the world. The cost of production of whey drink was found to be very cheap and hence it can be used by all class of people. Results obtained in this study are quite encouraging compared with pure whey. The keeping quality of acido-whey drink was also good upto ten days of storage. Further, the cost of production is also very cheap. Beverage manufactures are taking a serious look at how to add valuable nutrition to their product and whey is an ideal option. Hence, development of such a value added product can provide a new outlet for the use of whey in a more nutritious product.

REFERENCES

Effect of pH in the bioethanol production from cheese whey using the yeast *Kluyveromyces marxianus*

M. Seethalakshmi and M. Sankar

Faculty of Agriculture & A.H. Gandhigram Rural University, Gandhigram 624 302, Tamil Nadu, India.

Abstract

Ethanol fermentation of cheese whey by using *Kluyveromyces marxianus* MTCC 242 in batch experiments showed that pH 5 to be most suitable for maximizing ethanol concentration. The maximum yield coefficient of ethanol i.e., 0.425 g EtOH g sugar⁻¹ was observed at pH 5.

Keywords: bioethanol, fermentation, *Kluyveromyces*, pH, yeast

INTRODUCTION

The world production of cheese whey is estimated to be over 16 million tonnes per annum (Griba et al., 2002). The predicted value for whey production in India is estimated at 4.84 million tonnes per annum (Raju et al., 2005). Typical cheese whey contains 5-6 percent lactose, 0.8 - 1 percent protein, and 0.06 percent fat, constituting an inexpensive and nutritionally rich raw material for ethanol fermentation (Zafar and Owais 2006). Cheese whey represents an important source of environmental pollution due to its enormous global waste generation rate (to make 1 kg of cheese, 9 kg of whey is generated) and high organic matter content, exhibiting BOD and COD values of 50 and 80 g l⁻¹, respectively (Ozmihi, and Kargi, 2007). The biodeconversion of lactose to ethanol is a promising alternative that would not only reduce the environmental impact of cheese whey but also present an alternative way of production of ethanol as a valuable fuel resource (Rapin et al., 1994). Extensive attention has been paid during the last 15 years to the evaluation of whey permeate as a potential alternative fermentable substrate for alcohol production. Among the various operating parameters influencing ethanol production, initial pH of the substrate is reported to be important. Kargi, and Ozmihi (2006) studied the effect of varying initial pH on ethanol production using cheese whey powder solution and reported that pH 5 was found as an ideal pH to maximize the final ethanol yield. However, the effect of pH on cheese whey solution as a substrate for ethanol production is not known. Hence, this paper ascertains the fermentation of cheese whey solution at different pH levels in order to find the most suitable pH level for ethanol production using the yeast strain *Kluyveromyces marxianus* MTCC 242.

MATERIAL AND METHODS

Experimental system

Batch experiments were performed by using sterile conical flasks. One hundred ml of sterilized cheese whey was taken in 500 ml conical flasks and 4 ml of 0.1 N NaOH was added in order to adjust the pH levels to optimum conditions and freshly prepared 10 ml pure *K. marxianus* culture was added. The conical flasks were prepared in duplicates. Inoculated conical flasks were prepared in triplicates and were placed in an incubator shaker at 30±2°C. Samples were withdrawn aseptically from the conical flasks periodically (24 h) for analysis of total sugar and ethanol production. Experiments were conducted at four different pH levels viz., 4, 5, 6 and 7.

Procurement and maintenance of Microorganism

*K. marxianus* strain MTCC 242 was procured from the culture collection centre of the Institute of Microbial Technology (MTCC), Chandigarh India. The strain was maintained on agar medium having the following composition: lactose, 20 g l⁻¹; bacloprpteine, 10 g l⁻¹; malt extract 3 g l⁻¹; yeast extract, 5 g l⁻¹; agar, 20 g l⁻¹. Slants were kept for 48 h at 30°C for the growth of the yeast cells and then they were preserved at 4°C for further use.

Analytical methods

Biomass was measured in terms of dry weight. Yeast cells were harvested by centrifugation for 10 min at 5,000 rpm and then washed twice with distilled water and weighed after 24 h at 100°C. (Dubois et al., 1956) Amount of reducing sugars was measured to using the phenol-acid method. Ethanol was estimated by the dichromate colorimetric method (William and Reese, 1950), which is based on the complete oxidation of ethanol by dichromate in the presence of sulphuric acid to form oxalic acid. The fermentation efficiency was calculated as:
Figure 1. Lactose consumption

Figure 2. Ethanol concentration

Figure 3. Changes of pH levels at different timings of fermentations
Ethanol produced/ Theoretical maximum ethanol yield from sugar x 100 (Theoretical maximum ethanol yield = 0.54 g ethanol per gram sugar)

RESULTS AND DISCUSSION

In all the experiments total lactose concentration (4.2 percent) level decreased with increase of time with the lactose consumption level being faster in the pH 5 when compared to the other pH levels of 4, 6, and 7. (Table 1 and Fig. 1)

<table>
<thead>
<tr>
<th>pH</th>
<th>24 h (%)</th>
<th>48 h (%)</th>
<th>72 h (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3.62</td>
<td>3.13</td>
<td>1.96</td>
</tr>
<tr>
<td>5</td>
<td>2.97</td>
<td>2.32</td>
<td>1.82</td>
</tr>
<tr>
<td>6</td>
<td>3.2</td>
<td>2.73</td>
<td>1.32</td>
</tr>
<tr>
<td>7</td>
<td>3.57</td>
<td>2.89</td>
<td>1.75</td>
</tr>
</tbody>
</table>

The ethanol concentration also reached the maximum level of 1.48 percent at 72 h in pH 5 (Fig. 2).

<table>
<thead>
<tr>
<th>pH</th>
<th>24 h (%)</th>
<th>48 h (%)</th>
<th>72 h (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.52</td>
<td>0.64</td>
<td>0.75</td>
</tr>
<tr>
<td>5</td>
<td>0.842</td>
<td>1.013</td>
<td>1.48</td>
</tr>
<tr>
<td>6</td>
<td>0.667</td>
<td>0.954</td>
<td>1.02</td>
</tr>
<tr>
<td>7</td>
<td>0.625</td>
<td>0.801</td>
<td>1.06</td>
</tr>
</tbody>
</table>

There is no change in the pH level in the experiment having the initial pH level 4. (Fig. 3). But in the other remaining pH levels even though there is no change in the first 24 h, after 72 h pH 5 and 6 had a slight decrease of 0.5. In the same way pH 7 was stable up to 24 h. But

<table>
<thead>
<tr>
<th>pH</th>
<th>24 h</th>
<th>48 h</th>
<th>72 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4.5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
<td>5.5</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>5</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Effect of pH in the bioethanol production from cheese whey after 48 h the level got reduced to pH 5 and then to pH 4.5 after 72 h.

Ethanol yield coefficient was calculated and the maximum ethanol yield coefficient was obtained at initial pH of 5 (0.42 percent, v/v ethanol) followed by pH 7 (0.343 percent, v/v). Ethanol yield coefficients at other pH levels of 4 and 6 were considerably lower than that obtained at pH 5 and 7. Fermentation efficiency indicated that pH 5 has given good efficiency of 60.9 percent followed by pH 6 (43.6%) and 7 (39 % and 38%, respectively). On the basis of the overall results it is concluded that pH 5 is suitable for good ethanol production from cheese whey solution.

ACKNOWLEDGEMENTS

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REFERENCES


Small and Medium Enterprises under Globalisation
Challenges and Opportunities

L. Rathakrishnan
SMALL AND MEDIUM ENTERPRISES UNDER GLOBALISATION

L. Rathakrishnan
Impact of Globalisation – Opportunities and Challenges in the Dairy Sector

Seethalakshmi, M and M. Sankar

Abstract

India possesses over 16 per cent of world cattle and some 57 per cent of buffalo population but it stands for only 14 per cent of world milk production. The sector is livelihood intensive and provides supplementary income to 60 to 70 per cent of rural households. The small and marginal farmers and landless constitute the core milk producer group, owning over 60 per cent of milch animal. The present system of milk production offers many challenges. The systems is characterised by low milk production per milch animal; and the households widely scattered, the quality of milk, existing pricing policy, lack of public awareness and ineffective regulatory mechanism are the greatest challenge to this sector. The next two decades would offer immense opportunities for dairy sector together with
associated challenges. The dairy sector hopefully would capitalise on the opportunities for the welfare of millions of families engaged in dairy farming and associated activities.

**Introduction**

India possesses over 16 per cent of world cattle and some 57 per cent of buffalo population but account for 14.20 per cent of world milk production. The sector is highly livelihood intensive and provides supplementary income to 60 to 70 per cent of rural households. Milk production takes place in millions of small and very small holdings; approximately 7 million households (HH) scattered throughout the country are involved. The small and marginal farmers and landless constitute the core milk producer group, owning over 60 per cent of milch animal.

From chronic shortages of milk, India has emerged today as the largest producer of milk in the world crossing 80 million tonnes (GOI 2002). This success story of Indian milk production has been written primarily by millions of small farm holder producers. Although the yields have remained quite low compared to the world standards, yet it has not only survived but also flourished. Several factors appear to have helped it flourish. The "Operation Flood", one of the world's largest dairy development programmes, which helped to create strong network and linkages among millions of smallholder producers, processors and urban consumers, was an important instrument in achieving this success. The commercial imports and exports of almost all dairy products had been banned and processing activity had been controlled through licensing, which favoured cooperative societies over private entrepreneurs. Since early 1990s, India embarked upon liberal policy framework, which got reinforced with the signing of Uruguay Round Agreement on Agriculture (URAA) in 1994. The dairy industry was delicensed in 1991 and the private sector including multinational companies (MNCs) was allowed to set up milk processing and product manufacturing plants. However, in 1992, controls were
brought back through the 'Milk and Milk products Order' (MMPO) with a view to have 'orderly growth' of dairy industry in India.

Opportunities of Milk Production

The world milk production is growing at 0.5 to 1.0 per cent per annum and is likely to be 600 million tonnes by 2020. With production of 200 million tonnes, India would account for one-third of global milk production. The structure of milk production at farm level is not going to change and small and marginal farmers would continue to play dominant role.

The productivity enhancement programme would provide opportunities for the dairy sector. Some of the areas are listed below:

- Breeding and providing First Class services including Biotechnology and Embryo Transfer Technology for production of breeding bulls.
- Fodder seeds production of legume, grasses, trees
- Green fodder drying and briquetting
- Straw treatment and supply of minerals and briquetting of roughages for scarcity periods and deficit feed / fodder production regions.
- Milking machines and parlours
- Animal housing for individual farmers

The changes likely to offer opportunities are in production of cheese and various value added milk products, cultured products, desserts, ice cream, long shelf-life milk products. This would also offer opportunities for production and marketing of equipments for such products and milk and milk product packaging. India is likely to become 'Hub of Dairying in Asia'. Many multinationals would target / source India for Gulf, Middle East and Asian markets.

The demand for milk and its products depend on the income level. It would therefore be influenced by GDP growth. Milk and Milk products are income and price elastic, elasticity of demand being between 1.15 – 1.65. A demand supply analysis mode at different levels of growth shows that 5 percent growth
in milk would be sufficient to meet the national demand in 2010 as well as 2020. Achieving a growth of 7 per cent in production is likely to result in large surpluses requiring creation of large infrastructure for procurement, processing, marketing and exports.

### Table 1: Demand and Supply of Milk Production in India

<table>
<thead>
<tr>
<th>Product</th>
<th>GDP Growth (%)</th>
<th>Demand 2010</th>
<th>Demand 2020</th>
<th>Milk Production 2010</th>
<th>Milk Production 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>4</td>
<td>95.60</td>
<td>126.00</td>
<td>111.65</td>
<td>159.20</td>
</tr>
<tr>
<td>Milk</td>
<td>5</td>
<td>103.70</td>
<td>142.70</td>
<td>119.60</td>
<td>194.82</td>
</tr>
<tr>
<td>Milk</td>
<td>7</td>
<td>122.00</td>
<td>182.80</td>
<td>136.49</td>
<td>250.94</td>
</tr>
</tbody>
</table>


### Table 2: Export Scenario of Dairy Products

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity (in mts)</th>
<th>Value Rs. Crore (US$ in million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998 – 1999</td>
<td>2568.42</td>
<td>13.65 (2.92)</td>
</tr>
<tr>
<td>1999 – 2000</td>
<td>6134.42</td>
<td>37.21 (8.12)</td>
</tr>
<tr>
<td>2001 – 2002</td>
<td>24774.13</td>
<td>182.45 (39.83)</td>
</tr>
</tbody>
</table>


About 47 per cent of milk produced is retained in the house for household consumption and the surplus sold to available marketing channel. Organised sector (both cooperative and private dairy plants) handle about 20 per cent of the marketable milk and the balance is handled by unorganised sector.

### Challenges of Dairy Industry in the Globalisation Scenario

The present system of milk production offers many challenges. The system is characterised by low milk production per milch animal and households are widely scattered, milk...
production are seasonal, and these seem regional imbalances. The Government policies to promote dairying in non-viable areas offers challenge to dairy sector. The lack of zoning of livestock production makes optimum utilisation of resources difficult. The quality of milk pose greatest challenge to the system due to poor infrastructure. Existing pricing policy which does not provide incentive to quality, lack of public awareness and ineffective regulatory mechanism are some of the challenges faced by Indian dairy sector. The major challenges to future development arise on account of Quality Assurance. To meet the challenge, the national Quality Standards require harmonisation with international standards. The existing inadequate infrastructure for quality of milk should be upgraded.

Much needs to be done to improve the quality of the milk. One cannot make good quality products from bad quality milk. One has to adopt clean milk production techniques. Milk should be chilled instantly at the village level and transported to the dairy plants in chilled condition rather than at ambient condition. Everyone knows that milk is the ideal medium for the growth of bacteria and the bacteria multiply at much faster rate at room temperature as compared to 4 degree C. So, one has to go for VLCC system with farm bulk coolers installed as many as possible to improve the quality of milk.

Bactofugation technology will have to be adopted as much as possible. The technology to improve productivity is available and is being made use of in the development programme. High producing animals would require better management and feeding practices requiring change in production system. The small commercial milk productions have to be developed and attempts are to be made to diversify agriculture land for cultivation of fodder crops leading to integrated milk production with crop farming.

**Policy and Strategy**

Steps to improve supply system should include

Training and extension to enhance milk production per animal
Provision of technical inputs
Price incentive on the basis of quality of milk
Re-designing of the existing milk collection routes and addition of new economic routes
Introduction of bulk cooling / chilling
Introduction of stricter quality norms
Improved communication system.

**Strategy**

- The focus of the strategy should be:
  - A sustainable and financially viable livestock and dairy farming.
  - Technology support not only for enhancement of productivity but also for reduction of per unit cost,
  - Ensure policy environment influencing a wide range of services and service providers which have large employment potential,
  - Recognising institutional lending and remunerative price for rapid growth in livestock sector,
  - Supplement the impact of growth with special programmes aimed at special target groups, which may not benefit sufficiently from the normal growth process.

At the national level the strategy should include

- Greater budgetary and incentive oriented policy support to enhance productivity as well as impact quality at all levels in the dairy sector.

- To overcome the quality constraints, special incentives are to be given for clean and quality milk production.

- Enforcement of disease control measures to combat the prevailing diseases which have been acting as a deterrent to the animal health vis-à-vis the growth prospects of the livestock and dairy sector.

The policies related to quality are implemented at present primarily by the State and parastatal bodies, which are lesser effective. Therefore, time bound action-oriented