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Full Length Research Paper

Feasibility of cheese production and whey valorization in the Adamawa Province of Cameroon

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Problems associated with perishability and distribution of local milk and milk products by small-scale producers in the Adamawa province of Cameroon, justified development of an easy process for producing pressed-dough cheese and flavoured whey. Production from raw milk was technically profitable with mean cheese and flavoured whey yields of 8.9 and 85,6% (w/w), respectively. The cheese and whey comprise 50 and 45.7 % (w/w), respectively, of the milk initial dry matter and were highly appreciated by about 90% of panellists. The profitability of a small-scale production unit was established based on 562 kg of treated milk per month. An initial investment of about US $6,205 generates a monthly profit margin of US $237, which gives a profit of 45.8%.

Key words: Adamawa, milk, cheese, whey, feasibility, profitability.

INTRODUCTION

The economy of the Adamawa province of Northern Cameroon relies essentially on animal breeding, with a cattle head-count of about a million and milk production estimated at 10,000 litres per day (Douffissa, 1987; Douffissa, 1988). Most of the production is consumed as produced and the rest is transformed into fermented milk (*Pendidam* and *Kindirmou*) and other associated products which, however, generally have a short shelf life (Dury et al., 2002; Essomba et al., 2002). The production of cheese, much richer in proteins, would present an added advantage since it keeps longer and is easier to transport. This production, however, generates large quantities of whey comprised essentially of lactose, water-soluble proteins like β-lactoglobuline and α-lactalbumine, mineral salts and vitamins. These elements confer a high nutritive value to the whey (Alais, 1984).

Several methods have been proposed on the valorization of whey (Rech et al., 1999; Barinotto and Benedet, 2000; Zohri, 2000; Domingues et al., 2001; Ferrari et al., 2001) though their application under tropical conditions appears difficult considering the complexity and costs of equipment involved, as well as the need for numerous purification stages of the final products. As concerns local cheese production, there is scanty literature on techniques of its improvement (Dipeolu et al., 1999) as opposed to those for yoghurt, incorporation of the latter into other preparations (Millière et al., 1996), or on the study of profitability of milk production per cow (Goldman, 1982). This paper presents a simple technique for producing cheese from milk using yoghurt starter, another for valorisation of whey, and an evaluation of the financial stability of a small-scale transformation unit under tropical conditions.

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MATERIALS AND METHODS

Materials

Milk of the Zebu cattle (*Bos indicus*) was bulked from small firms near the Ngaoundéré University campus (Manwi, Dang, Bini, Bidjoro). Samples were drawn at the start of the rainy season (April – May) when animals are fed essentially with fresh perennial herbs (Hurault, 1975). Freeze dried yoghurt starter (*YALACTA*) from local super markets, were a mix of *Streptococcus thermophilus* and *Lactobacillus delbruecki ssp. bulgaricus* strains. Other ingredients were rennet (force 1/15 000) of Texel Rhône-Poulenc (520 mg chymosin/L; Dangé-Saint-Romain, France), sodium chloride, calcium chloride and potassium nitrate (Analar grad). Liquid flavourings, powder colourings and sugar were obtained locally.

Production of leaven and pasteurisation technique

Leaven was obtained by mixing a teaspoonful of starter (2 g), 1 L of whole UHT milk and 1 g of yeast extract. The whole was incubated at 42°C for 3 to 4 h. The leaven obtained was partitioned in ten 100-mL pots and refrigerated (4°C) before use.

On arrival in the laboratory, fresh milk was subjected to pre-treatment. This consisted of filtering through a muslin cloth and resting for 5 to 6 h (maturation phase), as the action of natural micro-organisms of fresh milk improve traditional cheese flavour (Silva Castro and Furtado, 2000). The milk was then bulk-pasteurised by boiling for 2 min and cooled to 42°C. This pasteurization phase is indispensable for small scale industries.

Culture seeding, coagulation, cutting and pressing of curd

The cooled milk was cultured with lactic leaven (2 mL/kg of milk) while other ingredients were simultaneously introduced: rennet at 0.2 mL/kg as coagulant, calcium chloride at 0.08 g/kg to promote coagulation, and potassium nitrate at 0.05 g/kg to avoid holes in the final product. Milk coagulation was controlled at 10-min intervals and until complete coagulation (after ~ 30 min). The curd was cut into 2.5-cm sided cubes, strained lightly, transferred into perforated moulds (20 cm diameter and 8 cm height), and pressed with a relative pressure of 800 Pa for 24 h to extract residual whey.

Brine pickling and maturation

The pressed curd was immersed at room temperature in 1.11 M sterilized and filtered brine solution with a mass ratio product/solution of 1/5. It was retrieved after 24 h, placed on wooden blocks and the whole stored in a maturation chamber for 25 days (at ~12°C and 90% relative humidity) during which products was turned on their sides every 24 h. Before use, the wood was washed, disinfected for 30 min in aqueous sodium hypochlorite at 0.08% active chlorine, thoroughly rinsed with water and dripped dry. Mould growth appeared after 3 days of maturation and at each instance, products were washed with 0.274 M NaCl. The microorganisms involved at this stage produce various volatile compounds and induce typical flavour to the product.

Valorisation of whey, conditioning and preservation of products

The whey was filtered to eliminate all traces of curd. Thereafter, sugar (32 g/kg), colouring (yellow, pink or orange) and flavouring (pineapple, strawberry or vanilla at 0.1 mL/L of whey) were added. The mix was bulk pasteurised by boiling for 2 min.

The treated whey was poured into pasteurised plastic bottles and refrigerated (4°C) while the pressed dough cheese obtained was conditionned in sulphur paper and equally refrigerated.

Physico-chemical and sensory analyses

Dry matter content was determined by oven drying at 105°C to constant weight (Normes AFNOR, 1980) and pH readings were obtained using a pH meter. Protein content (factor 6 .25 x nitrogen content) was determined using the Kjeldahl method. Cheese yield was reported as the percentage ratio of cheese dry matter to that of raw milk.

A group of fifty trained panellists of ages ranging from 18 to 30 years was created. They tested the cheese and whey drink for taste, aroma and colour. The hedonic test (Köster, 1990) was used to categorise products using a scheme that ranging from 1 (detest extremely) to 9 (appreciate totally).

Financial evaluation

Based on the processing procedure retained, monthly variable cost factors as well as equipment indispensable for production were identified. To assess the acceptability of the cheese and whey drink and propose prices for these products, market trials were undertaken through the administration of structured questionnaires to potential customers.

Operational feasibility

The realisation of such a structure, in a rural setting, is much easier if the peasant farmers who are generally constrained by insufficient funds and limited technical knowledge, regroup themselves in Common Initiative Groups (CIG).

With regards to organisational and technical aspects, the structure requires the services of three agents: (i) a technician charged with the establishment of the unit for cheese and whey drink production; (ii) a managing officer (manager) in charge of supplies (raw materials and consumables), the distribution of finished products and general supervision of the production unit; (iii) a security agent who will be responsible for the preservation and conservation of the unit's property.

As earlier indicated, it is certainly more difficult for each individual farmer to generate the necessary funds for the development of a cheese and whey drink production unit. As a group, however, they will create the synergy (Mouillesceaux, 1997) required for the mobilisation of the initial own-capital (at least 20% of the investment costs) and obtaining loans from financial institutions. For a start-up, such bank loans cannot be above 3 to 4 times the amount of own-capital (Albagli and Henault, 1996).

RESULTS AND DISCUSSION

Physico-chemical properties

Initial analyses gave the raw milk a dry matter content of 12.8% (w/w), a protein content of 32 g/L, and a pH of 6.6. The milk could therefore be considered fresh and normal (Alais, 1984; Libouga et al., 2001).

Mass balance of the process

The general plan of the process for the production of cheese is presented in Figure 1. From the raw milk, 8.9 and 83.5% (w/w) of matured cheese and whey, respectively, were obtained. These corresponded respectively to 72 and 7% dry matter content. These results show that 45.7% of the raw milk dry matter is

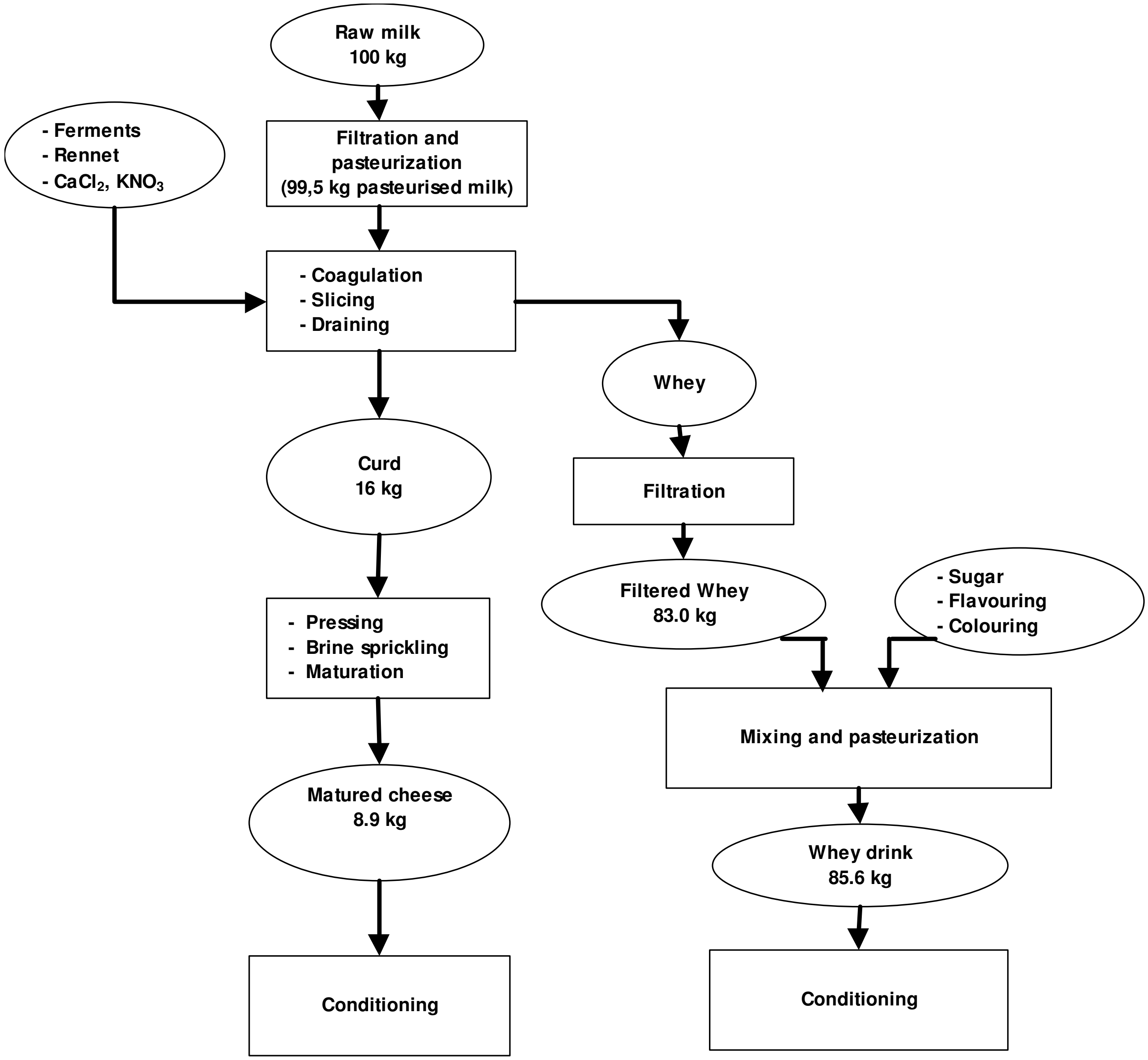

Figure 1. Mass balance of the pressed-dough cheese and whey drink process.

recovered in the whey. Hence the interest and need for its valorisation.

The sweet-flavoured-coloured whey drink mass obtained from 100 kg raw milk was 85.6 kg. The dry matter content of this drink was 9.8% and the protein content 1.8 g/kg. The yield in cheese, that is the percentage ratio of cheese dry matter to that of raw milk, was 50%, which is comparable to values found in literature (Veisseyre, 1975).

This process generated a global matter loss of 8%.

Organoleptic quality

The taste, colour and flavour of the cheese were considered excellent by 90% of panellists. The whey drink was most preferred when sugar, flavour and colouring were all present as opposed to when any of them was absent. The different colours (yellow, pink and orange) and flavourings (pineapple, strawberry and vanilla) were appreciated to the same extent.

Table 1. Materials for the cheese and whey drink production unit.

Nature	Lifespan (years)	Quantity	Unit price (US$)	Total cost (US$)
Gas burner and gas empty bottle	10	1	154.6	154.6
Pots	2	2	67.2	134.5
Thermometer	2	5	4.0	20.2
Coagulation trough	10	2	80.7	161.4
Cutters	5	4	6.7	26.9
Ladles	5	5	6.7	33.6
Curd press table	10	1	67.2	67.2
Manual Presses	10	6	65.0	390.0
Moulds	5	10	107.6	1,076.0
Filtration sheets/ Straining	0.5	10 m^2	1.3	13.4
Maturation chamber	10	1	1,345.0	1,345.0
Cold chamber	10	1	1,345.0	1,345.0
Office supplies	5	1	68.7	68.7
Others	5	-	-	133.5
Total				**4,970.0**

Table 2. Monthly balance sheet.

	Charges (US $)	Products (US $)
Raw materials	319.6	
Milk : 562 x US $0.54 = 303.48		Turn over
Transportation of milk : 4 x US $4.03 = 16.12		
		Cheese
Consumables	**295.6**	50 kg x US $16.1 = **805**
Rennet : 0.11L x US $26.9 = 2.96		
Water : 29.41 m^3 x US $0.46 = 13.53		Whey drink
Electricity : 862 KWh x US$ 0.08= 69		478 L x US $0.9 = **430**
Lactic starter : 0.003 kg x US $269 = 0.81		
Sodium chloride : 18 kg x US $0.8 = 14.4		
Calcium chloride : 0.045 kg x US $40.3= 1.81		
Potassium chloride: 0.028 kg x US $40.3= 1.13		
Sugar : (481 kg x 0.032 kg/kg) x US $0.54= 8.31		
Flavouring : US $1.33		
Colouring : US $1.33		
Gas : 10-kg bottle x US $6.7= 6.7		
Aluminium foil: 2 (30-m) packets x US $5.4 = 10.8		
Conditioning of cheese : 10 m^2 x US $13 = 130		
Conditioning of the drink : (~ 478 L x US$ 0.07 = 33.5		
Transport	13.4	
Other services consumed 40.6		
Rents : US $40.6		
Personnel charges	215.1	
1 Manager : 141.3		
1 Technician : 46.9		
1 Security agent : 26.9		
Taxes	13.4	
Other expenses	40.3	
Small working equipment : 13.4		
Unforeseen : 26.9		
Equipment depreciation	60.3	
Balance 1,235 – 998 = 237.0		
	1,235	**1,235**

Table 3. Classification of monthly expenses (in US $).

Nature	Variable	Total	Fixed
Raw materials	319.6		319.6
Consummables	295.6		295.6
Transportation	6.7	6.7	13.4
Other services consumed		40.6	40.6
Personnel charges		215.1	215.1
Taxes		13.4	13.4
Other costs	13.4	26.9	40.3
Equipment depreciation		60.0	60.0
Total	**635.3**	**362.7**	**998.0**

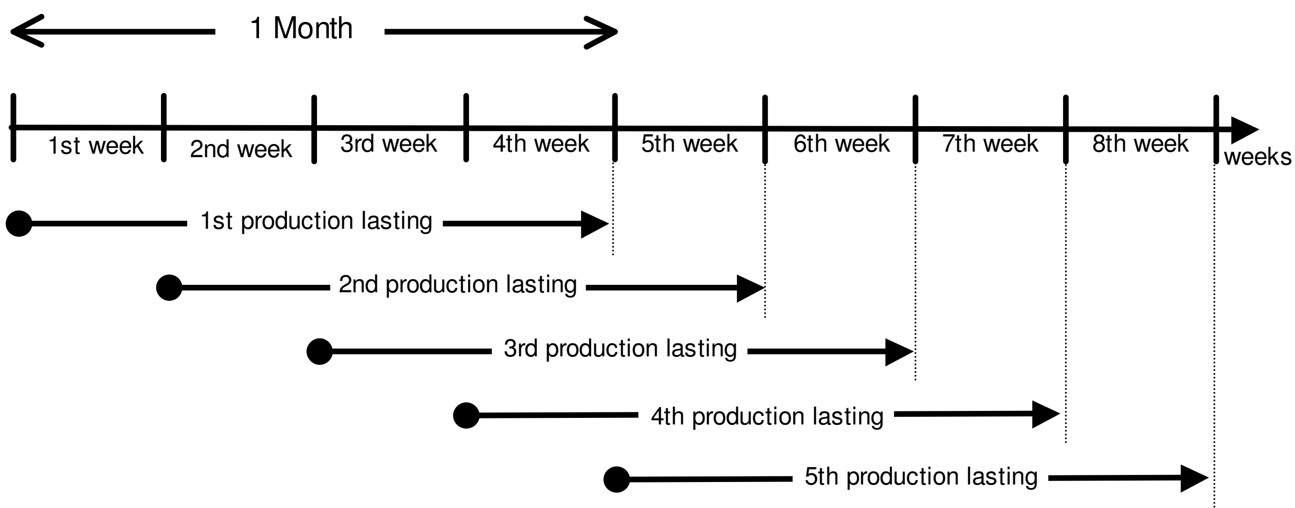

Figure 2. Monthly cheese production diagram.

Financial viability of production unit

The financial and economic indicators of the unit for cheese and whey drink production were evaluated with respect to capital requirements for start off, the profitability of the enterprise, and the determination of a profitability threshold.

The installation of a small milk transformation unit with the elaborated process necessitated the acquisition of equipment (Table 1), evaluated at US $4,970. Considering that operating the unit requires a running capital equivalent to the expenses for a month (Cf. Table 2), that is US $1,235, the economic capital needed for the running of the unit will be US $6,205. Prices of imported cheese in the local market range from US $12.8 - 26.6/kg, respectively for soft and for compressed cheese pastes. On the other hand, prices of bottled non-alcoholic drinks, similar to the whey drink, are about US $1.0/litre. Market surveys gave the prices of US $16.1/kg and US $0.9 /litre, respectively, for the cheese and whey drink.

The monthly balance sheet for production of 50 kg cheese and ~ 478 litres of whey drink, presented in Table 2, gave a profit margin of US $237. The production cycle of cheese being 28 days, this monthly production will be obtained in four weekly cycles treating each 140.5 kg of milk, on average.

Table 3 presents the distribution of the variable and fixed cost factors of the production unit. From these, the profitability threshold (PT), defined by Mikol et al. (1993) as the turn-over for which the production unit breaks even, was calculated. This threshold, which is the ratio of the product of turn-over and fixed costs, to the margin on variable costs (*Cf.* equation 1), was estimated at US $747.

$$PT = \frac{\text{Turnover x Fixed costs}}{\text{Turnover} - \text{Variable costs}} \quad (1)$$

The production margin (ratio of production to turnover) which translates the efficiency of our production unit was

19.2%, while the profitability of credits (ratio of annual balance sheet to total investments) was 45.8%.

Compared to results obtained by Dipeolu et al. (1999) on a similar production unit, the process described here will be more profitable after an effective valorization of the whey, and if an effort is made to reduce the initial capital investment (fixed costs).

Organisational implications

The personnel of the establishment (manager, technician and security agent) shall be employed full-time by the structure created and managed through the CIG. In effect, the production cycle for cheese being 28 days (4 weeks), a cycle shall be launched every week. This gives 4 production cycles launched in the course of a month though only one shall be effectively through at the end of the month (Figure 2).

CONCLUSION

This work evaluates the technical and economic feasibility of producing cheese in hot tropical regions by peasant small-scale milk producers. This method is presented as a means of better preserving and valorising their produce. The method developed was used for the production of compressed paste cheese that keeps longer when refrigerated, and also a drink from the main by-product, that was equally appreciated and commercially competitive. The milk collected at farm gate provides substantial revenue to the peasant breeders and could contribute to diversifying the feeding habits of local populations.

The establishment of a small transformation unit required resources that small-scale breeders could fully realise in a joint effort (Common Interest Groups, CIG). They will nonetheless, still require the technical assistance of specialised laboratories.

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