

5. TRAINING OF MILK PRODUCERS/PROCESSORS

5.1 Background

Namibia is located on the south-western coast of Africa and is largely a semi-arid country with a surface area of 824.5 thousands of square kilometers and an overall estimated population of 1.8 million (Population and Housing Census, 2001). Agriculture, despite its low Gross Domestic Product (GDP) share, is of major importance to the economy in terms of employment and export. The agriculture sector is divided into a commercial farming subsector, where farmers operate on freehold title land, and a communal farming subsector, where farmers operate on land under a communal tenure system. The two farming subsectors are separated by a Veterinary Cordon Fence (VCF), which is used in Namibia to control the spread of livestock disease from the communal areas in the north to the commercial areas south of the fence.

The communal subsector directly support 95 percent of the national farming population, but occupies only 48 percent of the total agricultural land and is characterized by low levels of agricultural productivity, high incidences of poverty, food insecurity, lack of appropriate farming methods and high unemployment levels. Farmers in communal areas mainly engage in subsistence rain fed crop and livestock production, and this makes the sector very vulnerable to changing climatic conditions, which is reflected in the high variability of output from one year to another. The sector is further constrained by poor marketing initiatives.

The livestock sector is an important subsector within the Namibian agriculture, as it accounts for 10 percent of the GDP and more than 25 percent of export earnings. The national cattle herds fluctuate from 1.8 to 2.5 million, the majority of which is found in the communal areas. In 1999, there were an estimated 1.46 million cattle, 267,146 sheep and 1.256 million goats in the communal farming areas of Namibia. At any single moment, a good portion of these animals are lactating, but dependence on rain fed agriculture results in a high variability of milk quantities between the seasons. Despite the large number of animals, people in the communal areas do not engage in economic activities with their wealth of livestock. Studies on rural livelihoods seem to suggest that, although communal farming is an important direct provider of staple foods for many rural households, there is extremely low or no cash income from the ownership of livestock in the communal areas.

This is especially the case in the northern part of the country where lack of cash income and economic hardship lead to poverty and cause under nutrition among children of less than five years old. Some farmers try to get cash income from their livestock by milking them, but do not know about proper technologies for adding value to their milk to increase returns, with the milk being wasted away due to spoilage or lack of market access. However, on-farm milk processing of butter and sour buttermilk does exist, mainly for household consumption. A very small part of these raw milk products is sold in recycled plastic containers by middlemen along the road for N\$ 2.50 per liter. Namibian Dairies, the main dairy company in the country, supplies dairy products to the urban areas from its location in Windhoek. The major consumer market apart from the urban areas lies in Ovamboland (North Namibia), but since these products retail at high prices, they are beyond the reach of most consumers.

The country continues to import a large volume of food products, and developing the agricultural sector is one of the options available to the Government if food security and improved nutritional status are to be realized. The Government of Namibia formulated the First National Development Plan (NDP1) in 1996-2000, which has assigned high priority for the eradication of poverty and achievement of food security and nutritional standards. Some of the projects and programmes initiated under the NDP1 are continued under NDP2 to meet the challenges facing the Government of Namibia, namely to reduce the gap between the wealthy commercial farmers and the communal farmers through increased productivity and commercialization of the latter, together with the necessary support services such as extension, credit facilities and marketing. One of the programme areas identified is dairy development in communal areas. This is to improve livelihoods through organizing small-scale milk collection and processing facilities, training farmers in proper dairy management, organizing farmers into dairy cooperatives and improving marketing infrastructure. At the same time, the programme will promote generation of complementary on and off-farm income and employment opportunities.

Currently, there is very little knowledge of proper milk handling on communal farms. With the milk still being processed in the traditional way, hygienic and safety measures are not exercised when handling the milk. Although no official data are available on current and

potential milk production and marketing of dairy products in the communal areas, it was observed that Namibia has the potential to produce enough milk to meet demand by mobilizing the small-scale dairy sector, but major problems are holding up progress. There is a general consumer perception that although locally processed milk and milk products retail at lower prices, they are unhygienic and unsafe. If affordable and efficient collection, processing and marketing systems are put in place, the quantity of locally produced milk available to processors and consumers could be increased significantly and the risk from zoonotic diseases, such as tuberculosis, virtually eliminated.

There is an urgent need therefore, to provide technical know-how and practical skills for those involved in getting milk and milk products from the farm to the consumer. This type of practical vocational training does not exist in Namibia and the Government has thus requested United Nations Food and Agriculture Organization (FAO) assistance to look into the potential and constraints of developing the milk production subsector in the communal areas and establishing a dairy demonstration and training centre in the northern communal areas. FAO experience indicates that small farmers can increase their net earnings from milk by up to 50 percent when they are directly involved in processing and marketing their own milk – milk that is surplus to their domestic needs. FAO studies (1985) in Africa and Asia indicate that up to six off-farm jobs can be created for each 100 L of milk collected, processed and marketed by small-scale sector.

The training will therefore demonstrate improved, low-cost, practical technologies for small-scale milk collection and on farm processing and marketing of butter and buttermilk. Butter production from cream, rather than from whole milk, will increase the yield by 50 percent. Proper milking, handling, collection and processing of pasteurized milk and fermented milk products will be demonstrated. These technologies allow relatively small volumes of milk and dairy products to be marketed cheaply and safely.

The main beneficiaries will be resource-poor milk producing households, in particular women, who are mainly responsible for milking and processing. Providing hands-on training will have an immediate and catalytic effect on mobilizing the small-scale dairy sector through increased and a more stable income from processed milk and dairy products. This in turn will

stimulate the adoption of technologies to increase milk production. Urban and peri-urban consumers and school children will indirectly benefit from safer and better quality products as more milk becomes available at affordable prices. Furthermore, many off-farm jobs will be created. It is estimated one job for each 20 liters of milk collected, processed and marketed. In addition, the Ministry of Agriculture, Water and Forestry (MAWF) will have gained valuable experience in the detailed design of its long term programme of dairy development strategy through this project.

5.2 Objective of training programme

The main objective of this programme is to improve the income and livelihoods of milk producers in the northern regions of Namibia through training of the milk producers/processors, extension officers and technicians of the Ministry of Agriculture, Water and Forestry and other state holders in improved milk production, handling, collection, processing and marketing of value added milk products.

5.3 Training needs assessment

After visits and going through the traditional milking, milk handling, processing, packaging and marketing process and interviewing the farmers, a list of training needs was established by the author covering milking, milk handling, animal health, co-operative venture, milk composition and laboratory analyses, hygiene, sanitation, processing, packaging and marketing as indicated below:

1. Training on animal health and husbandry (local diseases and feeding)
2. Training on formation of a small-scale milk producer organization (dairy co-operative society)
3. Training in hygienic milking practices and sanitation
4. Small-scale milk collection, transportation and preservation

5. Training on milk composition and simple quality control tests such as organoleptic, clot-on-boiling, acidity alcohol test, sediment, resazurin, fat and density tests, total solids of milk and solids-not-fat tests.
6. Training on small-scale milk processing into value added products such as butter, *Omashikwa*, *Omaere* (sour milk) and quality tests of the finished products.
7. Training in small-scale group dairy business management including record keeping and finally
8. Marketing of dairy products.
- 9.

5.3 Training

A large group of communal farmers comprising over 50 males and females (Fig. 5.1) were divided into smaller groups and were assigned training sessions according to the above needs. The trainers came from the Departments of Agric-economics, Animal Science and Food Science and Technology of the University of Namibia (UNAM) and the Cooperative Division of the Ministry of Agriculture. Training lasted for two months at Ogongo Agricultural College (UNAM Campus) where FAO donated processing facilities were installed as part of National Dairy Training Center for communal farmers in the country.



Figure:5.1 Communal farmers who participated in the training

5.3.1 Dairy training

Dairy training covered hygienic milking, safe milk handling, preservation and collection, transportation to the processing facilities, value addition, packaging, storage and distribution. In addition to this, the course also touched on milk composition, hygiene and sanitation, microbiology and laboratory analyses to ensure milk quality, shelf life and safety of consumers.

Besides traditional milk processing of *Omashikwa*, *Omaere* (sour milk), butter and ghee, the farmers were also introduced to yoghurt and cheese making in case they would like to venture into processing of modern products in the future. Using the FAO donated facilities shown below (Figs. 5.2, 5.3 & 5.4). They were taught to process Set and Stirred Yoghurts and Feta and Cottage type of cheeses, which do not need curing as such.



Fig 5.2 : Milk-Pro processing facilities at Ogongo used for training



Figure5.3: Cream separation for butter and ghee making



Fig. 5.4: Laboratory for milk analysis and quality control –Ogongo Campus

Farmers practiced making *Omashikwa* by following the laboratory method described in chapter 4.1. This made them aware of the improvements in the products quality that can be attained through the application of the technology. They were happy as the products were consistent and of good quality every time they were made, and this increased saleability at a better price.

At the end of the course, farmers were awarded with free milk cans donated by FAO and certificates of course attendance, which they were awarded by the Regional Agricultural Officer of the region. After training, the farmers were then left in the hands of trained Agriculture extension officers to proceed with their usual business of making the products on their farms. However, this time following the instructions given during the course of training so that they can produce quality and marketable products.

6 GENERAL DISCUSSION

The discussion in this chapter starts by critiquing the way key methods were used in this study with the objective of revealing strengths and weaknesses in the applications, as well as making suggestions for applying the methods better in future. It then compares the characteristics and quality of *Omashikwa* processed under traditional and laboratory conditions. Furthermore, it examines the effects of the *B. albitrunca* root on the microbiology and viscosity of *Omashikwa* and it examines sensory characteristics of the products for acceptability. A summary of the advantages and disadvantages of each of the two processing methods used are given, and recommendations for a more effective product processing technology designed for small-scale rural processing of *Omashikwa* are elaborated. Lastly, recommendations for further research work are given.

6.1. Methodologies: a critical review

As stated in the previous chapters, *Omashikwa* samples were obtained at random from households of *Omashikwa* processors in northern Namibia during the summer season. These were used for this study. Samples obtained from households were meant to represent all *Omashikwa* processors in the area in order to provide a wide variety of quality characteristics. However, the collection included only *Omashikwa* which was processed in summer and no samples were obtained in winter season. Sampling of *Omashikwa* in winter could give a broader presentation of microflora and sensory characteristics of the products processed in the two seasons. The reason for this shortcoming is that most of the producers who provided *Omashikwa* samples in summer did not have milk in winter due to seasonality of production and movement of livestock from vicinity to the cattle post for pasture and water. More complete data on the genera and growth pattern of microorganisms (thermophiles/mesophiles) from both seasons would have been generated if samples were available from the same source in winter (Feresu and Muzondo, 1990; Fantuzi *et al.*, 1992 and Beukes *et al.*, 2001). It has also been reported that traditional fermented milk products coming from regions with cold temperatures contain mesophilic bacteria such as *Lactococcus* and *Leuconostoc* species, while thermophilic bacteria, which include *Lactobacillus* and

Streptococcus, prevail in regions with hot tropical or subtropical climates (Thomas, 1985; Tamime and Robinson, 1988; Kurmann, 1994).

As stated in chapter 4.1, *Omashikwa* was processed using traditional technology methods similar to other traditional methods described by Walshe (1990) and Walshe *et al.* (1991). Milk was unfiltered and contained filth, was unpasteurized and cultures used were natural from traditional *Omashikwa* (back-slopping). Cleaned pieces of *B. albitrunca* root were simply added. The incubation temperatures and time were not controlled and butter removal was done by shaking or agitation of raw fermented milk containing natural enzymes including lipase. The use of raw untreated milk, back-slopping with natural culture and the process of agitation to remove butter were the main reasons for traditional *Omashikwa* to be accepted by only a low percentage (20%) of consumer panelists (Chapter 4.3). Traditional *Omashikwa* was too acid with bitter taste and rancid flavour caused by hydrolysis of fat. Rancidity and bitterness are attributed to churning of raw fermented milk to obtain butter in the presence of natural enzymes, including lipase (Deeth & Fitz-Gerald, 1995). It also contained a lot of extraneous dirt or filth and had significantly more whey separation due to poor fermentation process caused by poor hygiene, sanitation and uncontrolled fermentation temperature and time (Chapter 4.2).

Milk for laboratory *Omashikwa* on the other hand, was filtered and pasteurized at low temperature (65 °C/30 min) as opposed to high temperature designed for yoghurt making (85-90 °C/30 min). Bovine milk contains approximately 3% casein, which comprises 80% of the total proteins (Walstra and Jenness, 1984). Casein contains a number of protein fractions of which the most important are α_{s1} - and α_{s2} -casein, β - and κ -casein (Bylund, 1995). Casein is present in the form of spherical particles as micelles which are casein calcium-phosphate-complexes including small amounts of magnesium and citrate (Bylund, 1995). The micelles exhibit great heat stability in milk, but susceptible to changes in milk composition related to ions, salts concentration, processing and in particular to changes of pH (hydrogen ion concentration) (Walstra and Jenness, 1984; Lewis, 1986).

Serum or whey proteins in a native state exhibit a different behaviour as they are affected considerably during heat treatment of milk. These proteins start to denature at temperatures

above 65 °C (Walstra, 1990). A significant effect of denaturation may be observed by a considerable decrease in serum protein solubility under acidic conditions and complete coagulation in denatured form at pH 4.6-4.7, which is important for the technology of fermented milk (Walstra and Jenness, 1984).

Milk for this study was processed with a low temperature for the purpose of saving on firewood as a source of energy in the rural areas and also for comparing the role of the root in *Omashikwa*. This low temperature may not have been sufficient to denature all whey proteins (α -lactalbumins and β -lactoglobulin) and bind to casein micelles in order to absorb water and thicken the products, as it is done with yoghurt (Dannenberg & Kessler, 1988a, b). Pasteurization was used to simply control microorganisms from competing with *Omashikwa* starter cultures and to inactivate natural enzymes especially lipase in raw milk in order to prevent rancidity, poor fermentation process and sensory quality. The weakness of this study was that milk for laboratory *Omashikwa* was pasteurized at low temperature. Despite, the laboratory made *Omashikwa* was accepted by a high percentage (80%) of consumer panelists. In order to produce *Omashikwa* with a higher viscosity and lower syneresis, higher pasteurization temperatures ranging from 85–90 °C for 30 min could be used to denature whey proteins and bind casein, as described by Dannenberg and Kessler (1988a & b).

Viscosity in this study was determined as an important tool for assessing textural quality of *Omashikwa*, just like other fermented milks described by Corredig and Dalgleish, (1996). The instrument used to determine viscosity of the product samples was a rheometer, a device with a shearing and thinning effect on the product (Bylund, 1995; Walstra *et al.*, 1999). A weakness in this study was that the Brookfield Rheometer used was not necessarily the right one for the product as it has a thinning effect due to shearing on the texture of the product, as the spindle rotates. It would have been better to use Bostwick Consistometer that does not shear the product.

This instrument measures the consistency of a sample by its resistance to flow under specific conditions and for a specified time, and not by shearing effect as is done by Brookfield Rheometer. As such, some degree of variability in the ability to resist the flow may have resulted due to thinning effect, thus influencing the viscosity data of the two samples of

Omashikwa differently from other methods. However, while this may be perceived as a weakness in the study, it was the only instrument available at the time.

The role of *B. albitrunca* root in *Omashikwa* was determined in order to assess its effect on the microorganisms, viscosity and sensory attributes of *Omashikwa*. A weakness in this study was that, although it was found that there was slight bacterial inhibition activity, very slightly higher viscosity compared to other traditional fermented milks and improved taste and aroma of *Omashikwa* with addition of *B. albitrunca* root, the study did not determine the real compounds in the root that were responsible for these improved qualities.

Although compounds in *B. albitrunca* root were not determined, Makoi and Ndakidemi (2007) and Okolo *et al.*, (2007) reported that some phenolic compounds in plants may control the growth of microorganisms. Phenolic compounds are some of the most widespread molecules among plant secondary metabolites and are of great significance in plant development (Makoi and Ndakidemi, 2007). Their toxicity to microbes has also been reported by Mort and Dean-Ross (1994) and Bukowska and Kowalska (2003). Phenolic compounds are membrane damaging microbiocides and their overall toxicity is caused by distinct and complex mechanisms such as narcosis, the inhibition of growth and the uncoupling of adenosine triphosphate synthesis (Choi and Gu, 2001). High concentrations of phenols have been shown to be toxic even for species capable of using it as a growth substrate (Santos *et al.*, 2001). The activities of micro-organisms have also been observed to be inhibited by nitrophenols and some other phenolic compounds such as phaseolin, phaseolin isoflavin, kientone, quercetinglucoside, myracetin quercetin, tannins, syringic, phaseolin, p-hydroxybenzoic, ferulic, caffeic and chlorogenic acids and pisatin (Megharaj *et al.*, 1991, 1992; Makoi and Ndakidemi, 2007; Ravin, *et al.*, 1989). Some of these could be the phenolic compounds in the root of *B. albitrunca* tree that played a role in controlling the growth of microorganisms in the production of *Omashikwa*.

Soluble carbohydrates were found in *Omukunzi* root, and are known to assist Newtonian products to resist flow due to their gummy nature. However, as stated a weakness in this study was that the types of carbohydrates responsible for viscosity were not determined. The soluble carbohydrates responsible for thickening aqueous solutions and controlling rheological properties have, however, been described previously by Whistler and BeMiller

(1997) to be hydrocolloid compounds such as gums. The determination of the type of hydrocolloid present in the *Omunkunzi* root is important for future development as they could be extracted and processed into stabilizers, such as pectin, for commercial use.

Polysaccharides consist of monosaccharides bound to each other by glycosidic linkages (Belitz and Grosch, 1987). Their acidic hydrolysis yields monosaccharides. Polysaccharides can consist of one type of sugar structural unit (homoglycans) or of several types of sugar units (heteroglycans). The monosaccharides may be joined in a linear pattern, as in cellulose and amylose, or in a branched fashion (amylopectin, glycogen and guaran). The frequency of branching sites and the length of side chains can vary greatly (glycogen, guaran). The monosaccharide residue sequence may be periodic, one period containing one or several alternating structural units (cellulose, amylose or hyaluronic acid), the sequence may contain shorter or longer segments with periodically-arranged residues separated by non-periodic segments (alginate, carrageenans, pectin), or the sequence may be non-periodic all along the chain, as in the case of carbohydrate components in glycoproteins.

Polysaccharides are widely and abundantly distributed in nature, fulfilling roles as: structure-forming skeletal substances (cellulose, hemicellulose and pectin), assimilative reserve substances (starch, dextrans and inulin) and water-binding substances or hydrocolloid or gel (agar, pectin and alginate) in plants (Whistler and BeMiller, 1997). This could be the cause of viscous consistency of *Omashikwa* when *B. albitrunca* (*Omunkunzi*) root containing 19.4% of soluble carbohydrates is used in the processing of *Omashikwa*, traditional fermented buttermilk in Namibia (Chapter 4.1).

The natural taste, smell and flavour of compounds in *B. albitrunca* root could have been used by the traditional processors to mask and improved the poor sensory attributes of *Omashikwa* caused by poor milking, storage and processing environment. These were not determined. *B. albitrunca* root has a bitter taste and strong aromatic smell typical of the root. Though this appears to be a weakness of this study, it was not one of the objectives of the paper. However, previous studies on plant flavours have shown that simple phenolic compounds from plant materials can be responsible for imparting taste and smell to food products, including *Omashikwa* which is processed with the *B. albitrunca* root. In addition to the wide spectrum of functions narrated by Makoi and Ndakidemi, (2007), phenolic compounds are

also responsible for astringency, bitterness, colour, flavours and odours of plant products. The real compounds responsible for taste and aroma in *B. albitrunca* root can still be identified in future research work.

6.2 Enumeration of microorganisms from *Omashikwa*

The study of microorganisms in *Omashikwa* was aimed at enumeration, isolation and identification to species level. The study revealed that significant differences existed in microorganism counts on traditional *Omashikwa* compared to laboratory *Omashikwa*, with traditional *Omashikwa* showing lower numbers due to the addition of the *B. albitrunca* root. However, the growth of coliforms, yeast and moulds were insignificantly affected. The result of *Omashikwa* samples with added root had lower bacterial counts but it contained coliforms, yeasts and moulds just like laboratory *Omashikwa*. The presence of coliforms, yeast and moulds in laboratory *Omashikwa* were probably caused by back-slopping contamination with traditional *Omashikwa* cultures as described in other similar products by Shalo and Hansen (1973).

Identification of LAB to species level was carried out using the API 50 CH identification system, which is based on carbohydrates (sugars) fermentation in association with physiological and chemical tests such as morphology, Gram and catalase reactions. In general, phenotypic methods are cheaper compared to genotypic methods, which have stimulated the popular use of commercially available miniaturized identification systems such as API (BioMerieux). Although the application of phenotypic techniques has proven to be useful for certain LAB, there is a general awareness that similar phenotypes displayed by strains do not always correspond to similar or even closely related genotypes. Additional weaknesses of phenotypic methods include poor reproducibility, ambiguity in some techniques, extensive logistics for large-scale investigations and poor discriminatory power (Corsetti *et al.*, 2001). The API method was not able to identify some of the species because some identification pattern was not in the database. Phenotypic characterization based on sugar fermentation pattern, may not always provide sufficient basis for the reliable identification of LAB to species level, as reported by other researchers (Nigatu, 2000; Corsetti *et al.*, 2001; Muyana *et al.*, 2003), although it is a useful tool for classification. Sugar

fermentation pattern should be combined with conventional phenotypic properties or with genotypic techniques to be more accurate in identification of LAB to species level. However, the API method was simple to run and probably more effective compared to other methods usually carried out such as biochemical assay. There has been a shift towards the use of genotypic characterization methods in order to provide a more robust classification and differentiation (McCartney, 2002).

The most predominant species of microorganisms found in both products were *Lactobacillus plantarum* and *lactis*; *Leuconostoc lactis*, *Leu. dextranicum* and *Leu. citreum*; *Lactococcus lactis* and *diacetylactis* and *Streptococcus thermophilus* species. A weakness in this study was that a more efficient method of identification could have been used with better results. The molecular method using gene (DNA) sequencing such as 16S rRNA Sequencing method (Marziali, A. & Akesson, M., 2001), the DNA Checkerboard Hybridization method (Socransky *et al.*, 1994) and Genomic DNA Probes method (Siqueira *et al.*, 2002), to identify the microorganisms to species level could have been used with better results but neither the department nor the faculty has the equipment to do it. The genotypic characterization techniques are also not without limitations such as cost of equipment and databases etc. and thus a polyphasic or combined approach is preferred (McCartney, 2002).

The viscosity of *Omashikwa* processed with the addition of *B. albitrunca* root was slightly higher than that of laboratory *Omashikwa* processed without the root. Besides *B. albitrunca* root, viscosity could also be attributed to lactic acid bacteria that are responsible for production of viscous polysaccharide compounds. Examples of such bacteria include *Streptococcus thermophilus*, *Lactobacillus delbrueckii* subsp. *bulgaricus*, including some species of *Lactococcus lactis* subsp. *cremories* and subsp. *lactis* (Nakajima *et al.*, 1990; Cerning *et al.*, 1992). These viscous compounds include polysaccharides such as exopolymers that have been described by Nakajima *et al.* (1990); Cerning *et al.* (1990, 1992) and Bubb *et al.* (1997). A layer of these polysaccharides built of sugar residues can envelop the bacteria cell and form capsules known as glycocalix or can be excreted into the medium in the form of slime known as exopolysaccharides or homopolysaccharides (dextrans) which are responsible for viscous consistency. This study found that lactic acid bacteria that are responsible for production of polysaccharides were present in *Omashikwa*.

6.3 Effect of pH on viscosity of fermented milks

The fundamental structure of fermented milk is composed of casein network. The formation of a gel during the manufacture of fermented milk is basically due to quiescent acidification caused by bacterial fermentation. During the acidification of milk by fermentation, colloidal calcium-phosphate, which binds the casein micelles together, is leached out into the serum. As the pH reaches 5.2, β -casein also leaches out of the micelles into the serum. The micelles disintegrate into sub-micelles that aggregate forming a network. Serum protein and fat globules are trapped in the casein network (Driessen and Puhan, 1988).

As the pH decreases during bacterial acidification, the viscosity of the gel increases dramatically as the pH drops to below 5.2, which is also around the pH value where network formation starts. At pH below 5.2, β -casein seems to reaggregate into the protein network with the other caseins. The viscosity reaches a maximum at a pH *ca* 4.6-4.7. The on-set of gelation and the rheological properties of the acid gel are, however, influenced by heat treatment of milk, the acidification temperature and the composition of the milk (Heertje *et al.*, 1985; Parnell-Clunies *et al.*, 1986; Dannenberg and Kessler, 1988a, b; Vliet van and Keetels, 1995).

6.4 Descriptive and consumer sensory analyses

Einstein (1991) defined descriptive sensory evaluation as “the identification, description and quantification of the sensory attributes of a food material or product using human subjects who have been specifically trained for this purpose”. As such, the success of the descriptive sensory analysis exercise relies primarily on the collective ability of the descriptive panel to reliably and precisely grade and differentiate the products from given attributes. The panelists found traditional *Omashikwa* to be bitter in taste due to rancidity and with a strong aromatic smell originating from the *B. albitrunca* root, besides lactic acid taste, whereas the flavour and aroma of laboratory *Omashikwa* were that of lactic acid and aroma compounds originating from lactic acid fermentation such as diacetyl. According to the *Omashikwa* processors, the flavours and aroma from *B. albitrunca* root are used to mask and modify the poor taste and smell of traditional *Omashikwa*, which are acquired from the raw milk and picked up from the environment during milking, handling and processing (Chaper 4.1). These

off-flavours and odours are collected from the unsanitary and unhygienic milking environment; urine, cows, water, milk handlers and milking equipments, as described in other similar traditional fermented milks by Kimonye & Robinson (1991); Marshall (1992); Olasupo & Azeez (1992). Since the *Omunkunzi* root flavour and smell are distinctive and strong, they can easily be detected from the product, as was the case in the sensory analysis exercise carried out by the descriptive panelists (Chapter 4.3).

Rancidity was probably caused by the hydrolysis of fat in the presence of lipase enzyme during agitation of raw fermented milk to obtain butter, which was also reported in other fermented milks by Walstra *et al.* (1999). Bitter favours in *Omashikwa* were probably caused by hydrolysis of fat and proteins or acquired from *B. albitrunca* root, as it is naturally bitter as detected by the descriptive sensory panelists (Chapter 4.3). Filth content was high in traditional *Omashikwa* and was probably caused by poor milk handling, hygiene, unsanitary conditions and lack of filtration of milk prior to fermentation in the rural areas as reported in other similar products by Cousins and Bramley (1981) and this may explain the 80% of consumer's preference for laboratory *Omashikwa*.

6.5 Use of the knowledge gained to improve the quality of *Omashikwa*

It has been confirmed by this study that the quality of traditional fermented milk, *Omashikwa* can be improved in terms of increased viscosity, reduced syneresis and improved flavor and smell by the use of *B. albitrunca* root. However, the quality has been variable and poor in consistency due to poor hygiene, sanitation, fermentation and processing technology. There is a need therefore to improve the quality of *Omashikwa* for rural community so that its acceptability and marketability can be improved and sustained so that it can be expanded to reach a wider spectrum of consumers as described in other milk products by O'Mahony and Peters (1987); Tamime and Robinson (1988). This may generate more jobs and income to farmers for food security and alleviate poverty for the community concerned. The first approach would be to improve the hygiene and sanitation standards of milking by using clean environment, clean water and udder, clean and healthy milking personnel and handlers and by using clean and proper containers such as aluminium or plastic containers instead of

gourds. The second stage would be to ensure that the milk is filtered using clean cloth filters and cream is separated using hand separator or milk should be heat treated or pasteurized before fermentation. This should be done before shaking or agitating to obtain butter.

Shaking of raw fermented milk would rupture the membrane of the fat globules, allowing liquid fat to escape and be hydrolyzed by the natural lipase enzymes present in milk to rancid flavour, if not pasteurized (Walstra *et al.*, 1999). Pasteurization of milk to at least 85-90 °C/30 minutes or boiled in order to kill all the unwanted microorganisms and inactivate enzymes for quality product and to render it safe for human consumption is the critical point. This temperature time combination or boiling would also denature whey proteins and combine with caseins to make the end product more viscous by binding water, as reported by Dannenberg & Kessler (1988a and b); Mottar *et al.* (1989) and Corredig & Dalgleish (1996). The milk should then be cooled to ambient temperatures of 25-30°C in a water bath or at room temperature before inoculation with good quality *Omashikwa* cultures (back-slopping) and incubated at 25-30°C for 2-3 days or at room temperature until fermented (Fig. 2.1). At this stage, if *Omunkunzi* root is still needed, it can be added for flavour, smell and viscosity but after thorough cleaning in hot clean water to remove dirt and destroy yeasts and moulds. The product should then be covered to prevent contamination during incubation period. After fermentation, the product can then be cooled to below 10°C, if facilities are available, and gently agitated to mix to homogenous and smooth consistency for packaging.

Alternatively, immediately after inoculation, the product can be packed in appropriate, cheap plastic bags, sealed and incubated in the packets to avoid post-pasteurization contamination. The *Omashikwa* can then be distributed for sale in sealed plastic packets instead of dirty recycled bottles as indicated and shown in Chapter 1.

The cost here will only include the purchase of a hand separator, plastic pouches and a sealer. Others will include boiling pots, storage milk cans, filter cloth and firewood. A cooperative venture would be an ideal approach here so that some of these items could be donated by agencies like Food and Agriculture Organization of the United Nations (FAO), farmers associations and the government through extension services, when approached for assistance.

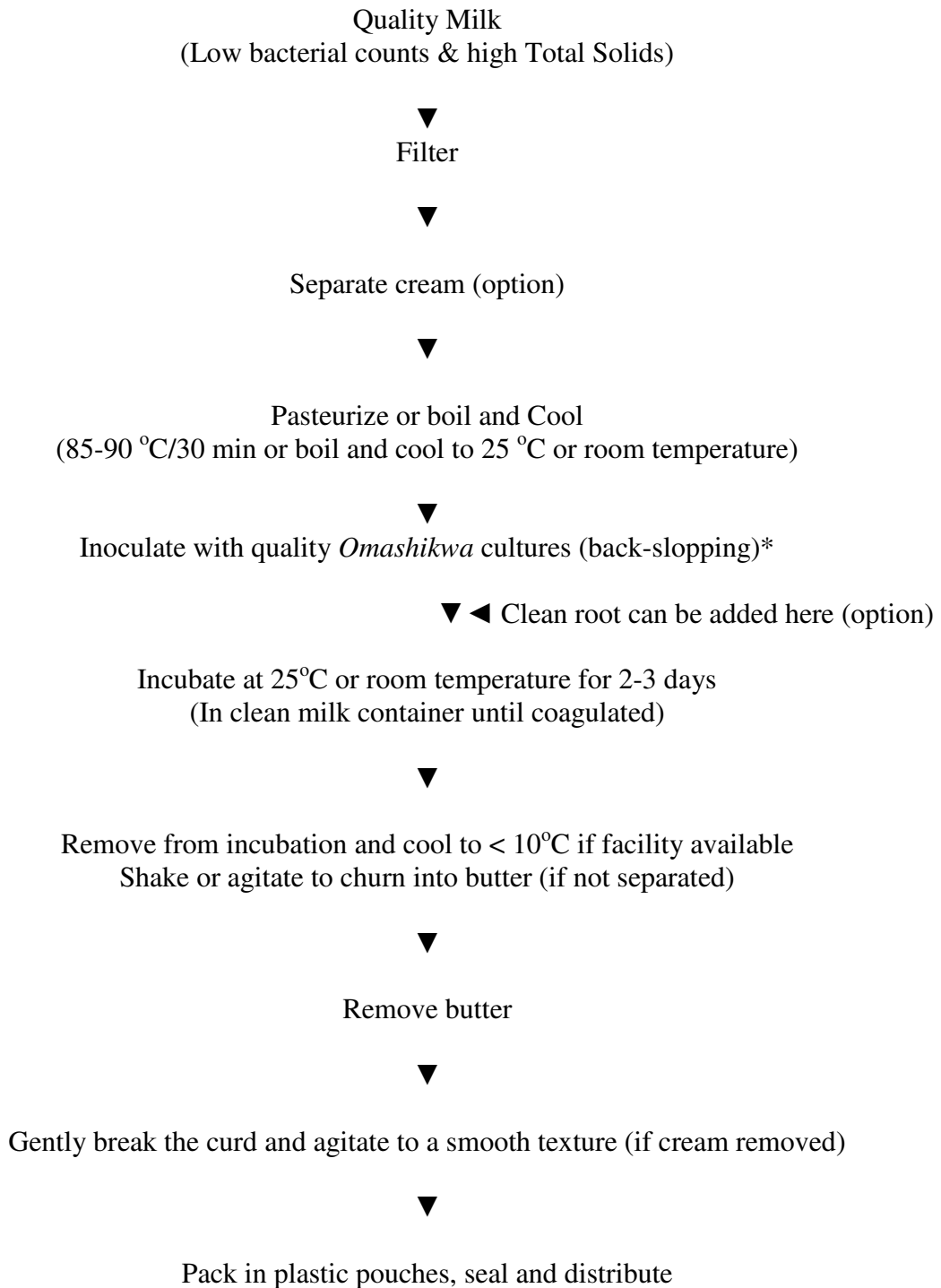


Figure: 6.1 Flow-chart of the proposed small-scale *Omashikwa* processing

Note:

*Alternatively, it can be packaged and sealed after inoculation and incubated in packets. It is safer to ferment in packets to avoid recontamination during packaging in the rural set up.

6.6 Recommendation for future research

As a follow up of *Omashikwa* studies, it would be desirable to collect milk during the winter period to see if the microflora would be different from those of summer season and whether this will have effects on the quality of *Omashikwa* due to mesophilic and thermophilic lactic acid bacteria as reported by other researchers (Thomas, 1985; Tamime and Robinson, 1988; Kurmann, 1994).

It is also important to test other methods of microbial identification like for example, identification of LAB to species level using molecular biology or DNA sequencing method (genotype) and comparing it to API CH system (phenotype) which is sugar fermentation based, or others methods in order to provide a better picture and recommendations for their use in future research.

The bacterial inhibition compounds in the *B. albitrunca* root is another area which could be looked into. These compounds need to be determined to ascertain the types that are responsible for controlling microbes in *Omashikwa*. If they are effective, they could in future be extracted and processed for commercial purpose.

The taste and aroma of compounds from the root are traditionally used by *Omashikwa* processors to mask the poor flavour and odours originating from poor surrounding environment of milk production. These flavours and aromatic compounds need to be identified to know what they are and whether they could be extracted and processed for commercial purpose, just like other food flavourants in the market.

The soluble carbohydrates (hydrocolloids) in *B. albitrunca* root responsible for viscosity of *Omashikwa* also need to be identified and extracted for commercial purposes. The soluble carbohydrates can be made into products like stabilizers such as pectins etc. found in the market. It will be more convenient to use the processed products instead of fetching the roots every time *Omashikwa* is processed.

7 CONCLUSIONS AND RECOMMENDATIONS

During the course of this study, it was observed that *Boscia albitrunca* (*Omukunzi*) root plays a role in slightly improving the viscosity of *Omashikwa*, slightly controls microorganisms and also improves the sensory attributes and acceptability of *Omashikwa*. However, poor handling of milk and processing technology results in poor product quality. These therefore need to be addressed in order to control, stabilize and improve the current variable quality of *Omashikwa* in general. The problems are in the physico-chemical and sensory characteristics with high syneresis, filth, bitterness, rancid flavour and low viscosity and acceptability by the consumers. Addressing the issues will enable the product quality to improve and be distributed to a larger area and to a wider spectrum of consumers in Namibia, thus creating more jobs and generating more income for food security and general welfare of the community concerned. Good manufacturing practices including hygiene and sanitation, use of proper lactic acid starter cultures in a controlled environment and distribution of the product in proper and affordable containers will enable the community to succeed in their endeavors.

Training of rural milk producers and processors is the prerequisite and important recommendation issue for the exercise to work. The training should cover areas of hygiene, sanitation, processing, preservation, packaging and marketing of their commodity. Training should be emphasized if communities dealing with the product need to come out of the vicious circle. It is very important to empower them especially the women with knowledge and skills of milk processing technologies to enable them to appreciate the quality and produce acceptable product for general consumers. The idea is to market their product to a wider area and generate more income. This will liberate the farmers from poverty and allow them to forge ahead with milk business in order to alleviate the problems of food security and hunger.

Since traditional microorganisms in *Omashikwa* is one of the culprits of poor fermentation process, it is further recommended that the veterinary service centres or such institutions like Ogongo Campus of the University of Namibia, should propagate and store quality lactic acid fermenting cultures in order to supply to the farmers when needed. Cultures, such as *Lactobacillus plantarum*, *lactis* and *cremoris*; *Lb. delbrueckii* subsp. *bulgaricus*; *Lactococcus*.

lactis and *cremoris*; *Leuconostoc lactis* and *cremoris* and *Streptococcus thermophilus*, could be isolated from traditional fermented milk products and made into mother cultures and stored chilled or frozen for farmers use. The cultures can then be distributed to *Omashikwa* processors individually or through their Cooperative Society for distribution in the rural areas when needed. This should be handled in the same manner they handle veterinary medicines, vaccine and semen for farmers. This will enable *Omashikwa* processors to access quality cultures and to use the knowledge gained during training sessions to process better products.