A REVIEW OF CHEESE PRESERVATIVE TECHNIQUES

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ABSTRACT

Cheese provides a high concentration of nutrients relative to its energy content. It is considered to be an adequate source of valuable macronutrients (fat, protein, lactose), vitamins and micronutrients (minerals), making it a 'wholesome food'. The nutritional composition of cheese depends on the type of milk used and the manufacturing procedures. Due to the fact that cheese is made of milk it contains various microorganisms which make it susceptible to spoilage within a short period of time. The capacity to preserve cheese like any other food is directly related to the level of technological development. The slow progress in upgrading traditional food processing and preservation techniques in West Africa contributes to food and nutrition insecurity in the sub-region. The soft cheese which is common in Nigeria has an average shelf life of two to three days at ambient temperature of approximately 28^0C and the attempts have been made in the past to preserve the cheese by the use of preservatives. Some of these preservatives have been shown to be effective in inhibiting spoilage. Notable efforts include the use of preservatives such as nisin which is used as food preservative particularly in cheese production; curcumin microcapsules is a preservative for cheese due to its antimicrobial effects and chitosan is effective in inhibiting the growth of spoilage microorganisms in cheese. However in the cheese industry the use of preservatives has some drawbacks which lower activity, stability and bio-availability. Therefore, other methods such as the use of modified atmosphere packaging, refrigeration, freezing of cheese and frying have been applied which only extend the shelf life of cheese for a short period of time while freeze drying of cheese gives the final product of a high quality with longer shelf life.

Keyword: Cheese**,** refrigeration, preservatives, freeze drying, deep frying

1.0 Introduction

Cheese is a product made from the curd obtained from milk by coagulating the casein with the help of rennet or similar enzymes in the presence of lactic acid microorganism (Ramakant, 2006). Cheese is the fresh or ripened product obtained after coagulation and whey separation of milk, cream or partly skimmed milk, buttermilk or a mixture of these products, it can also be made from the milk of cows, sheep, goats and camels or mixture of two of these (Herrington, 2001). The objective of cheese making is to obtain the optimum cheese composition with respect to moisture, acidity, fat, protein and minerals. Cheese provides a high concentration of nutrients relative to its energy content. The nutritional composition of cheese depends on the type of milk used and the manufacturing and ripening procedures (Andrew, 2010, Ramakant, 2006).

Each type of milk imparts the characteristics quality of cheese made from it and the resulting cheese will differ in its proprieties, body texture, and flavor (Andrew, 2010). There are great varieties of cheese, some are perishable and must be consumed within few days while other can be stored for years (Herrington, 2001). White cheese is the only type of cheese available to the public in large quantities in most Nigerian markets. Warsama *et al* (2006) reported that Nigerian white soft cheese contained 47.8% total solids, 14.0% fat, 15.9 % protein and 6.2% ash. Natural cheese should be stored at suitable temperatures to ensure good quality because a high temperature leads to evaporation of moisture and growth of unwanted bacteria and other faults (Ramakant, 2006).

The demand for dairy products in sub-Saharan Africa continues to increase with the overall growth rate in the consumption of milk and milk products being estimated at about 2.1% per annum. The growth in demand results from rapidly rising populations, urbanization and some increase in per capita income. On the basis of population growth alone (about 15 million per annum) and a constant per capita consumption level of 27 kg the total requirement for dairy products would increase by 400 million kg each year. An increase in per capita incomes would add to this demand and it is projected that total demand will grow at least by 4% per annum at current levels of production (Connor, 2003).

This increasing demand for milk and dairy products affords great opportunity and potential for the small holder milk producer and for the development of the milk production and processing industry (Connor, 2003). Nowadays, cheese consumption is widely spread throughout the world. However, the amount of cheese eaten is very different from country to country. Nevertheless, cheese consumption has risen continuously in recent years. Today the main reason for the consumption of cheese is not the prevention of hunger but the supply of important and essential nutrients (Ramakant, 2006, Andrew, 2010).

Technological progress has led to a multitude of different types of cheese in the market, varying in texture and also flavors (Andrew, 2010). Therefore, research is no longer based on the production of high quality cheese but more on the commercialization of cheese as a functional food. Technology is needed for gentle processing to retain or even accumulate desired nutrients and to remove undesired compounds. Since more and more individuals would like to control their health via custom-made food, the worldwide market for functional food is one of the fastest-growing markets in the world (Herrington, 2001, Warsama *et al.* 2006).

2.0 Types of cheese

The various cheese types can be classified according to the milk used, their manufacture, consistency, and fat content. The varieties of cheese in the market are enormous, which is also reflected in the variability in the composition of the different types of cheese. Cheeses may be broadly grouped into ‘soft’, ‘semi-hard’ and ‘hard’ cheeses.

a) Soft cheeses

Soft cheeses are easier to make than hard cheeses and are traditional foods that are popular in many countries. Soft cheeses are made using lactic acid bacteria or an acid, such as lemon or lime juice or vinegar. These cheeses are soft, moist, creamy cheeses and include curd cheese, and small-curd cottage cheese. Those made from buffalo milk are white and those made from cows’ milk are pale creamy yellow, with a shelf life of around 3 days when refrigerated, or 5 days if covered with brine and refrigerated (Andrew, 2010).

Soft cheese is produced by lactic acid bacteria but some soft cheese may also be produced by adding acid. Both methods coagulate milk to create pieces of semi-solid curd. The curd may be

heated up to 52^{o}C to inactivate the bacteria and prevent further acid development. Washing the curd before salting also reduces the acidity. In many countries, traditionally produced soft cheeses have a sour taste and pronounced flavour (Liu *et al,* 2006) which are made using fermented buttermilk which is heated gently for about 30 minutes until completely coagulated. It is then cooled, and the whey is drained to leave the cheese. It is pressed into blocks and stored in brine until it is sold. Examples of soft cheese are cottage cheese and cream cheese.

b) Semi-hard cheeses

This is a large group of cheeses which includes Edam, Gouda and Colby. Production is by rennet coagulation and lactic acid production is restricted. The amount of moisture removed from the curd depends on the temperature and time of cooking and by the wash water temperature. Higher temperatures during cooking or washing cause the curd to contract and expel more moisture. Typically, these cheeses are matured for between 2 weeks and 9 months (Anderson *et al,* 1999).

c) Hard cheeses

Hard cheeses include Cheddar, Parmesan, Swiss and Romano, which have lower moisture contents than other types, it is produced by higher temperature cooking or by controlled fermentation and curd handling. Pasta Filata types are worked and stretched in hot water and salted using brine. Cheddar types are salted before pressing. The cheeses are ripened for 1-36 months (Andrew, 2010).

d) Halloumi

Halloumi is a firm pickled cheese with its origins in Cyprus where it is made from sheep or goat milk or a mixture of both. It can also be made from cow milk. The cheese may be eaten fresh or after storage in a cool store. If it is stored below 12^{o}C, it will keep for several months. After salting the cheese pieces may also be stored in plastic bags without brining; if stored at about 10^{o}C the cheese has a shelf-life of two to three months (Liu *et al*, 2006). About one kilogram of cheese will be obtained from nine litres of milk.

e) Scamorza

Scamorza is a Pasta filata type cheese produced by smallholders in some regions of East Africa, such as Tanzania and Kenya. Other Pasta filata type cheeses are Kashkaval, Caciocavallo and Mozzarella. Scamorza cheese is made from whole or standardized milk (some of the fat is removed). The cheese, which weighs about 400g, is ready for consumption when it is between three and five weeks old. For the market place it is important that the shape, size and quality of

the cheese are uniform and consistent. The appearance may be enhanced by applying a thin coating of butter to the surface of the cheese (Han, 2001). This may also reduce evaporation thereby increasing yields. About one kilogram of cheese will be obtained from 10 litres of milk.

f) Cheddar

Cheddar cheese has its origins in Britain. Traditionally the cheese was made in different sizes from about 0.5 to 25 kg. The procedure for making Cheddar may be considered difficult and tedious by the inexperienced but the resultant mature cheese with its characteristic nutty flavour and close texture makes the task worthwhile. The Cheddar cheese recipe can be manipulated to give a cheese which may be consumed in four weeks or stored for up to two years. Therefore Cheddar offers the opportunity to preserve milk constituents in times of surplus milk production. In order to obtain a cheese of good body and texture it is necessary to use milk with about 3.3% fat (Liu *et al*, 2006). If milk with excess fat content is used there will be high losses of fat in the whey and the cheese will have a weak, pasty body.

g) Soy Cheese

Soy cheese is a traditionally important and popular food product. The historical evidence confirms that the making of soy cheese started centuries ago in China (Han, 2001) and the processing conditions differ a little in various localities of China. Originally soy cheese was a product of fungal fermentation but bacterial fermentation has also been carried out successfully (Liu *et al*, 2006). Soybean, the basic raw material for the product, has great nutritional (source of proteins, minerals, *etc*.) and therapeutic values (*e.g.* prevention of chronic diseases such as menopausal disorder, cancer, atherosclerosis and osteoporosis), and it is also beneficial in products like soy milk and soy cheese (Liu *et al* 2006; Anderson *et al;* 1999). Sodium Chloride and ethanol are the basic components of soy cheese, which provide the traditional flavour and the product safety against pathogenic microorganisms (Han, 2001).

h) *Wara* (West African Cheese)

Wara (West African Cheese) is one of the processed dairy products obtained from cattle's milk (Oladipo and Jadesimi, 2012). It is an unripened, soft and moist curd. The cheese is prepared by heat treatment of milk followed by addition of coagulant and removal from whey (which contains water, lactose, and vitamins) (Adetunji and Babalobi, 2011). The coagulation of the milk is traditionally done by the Fulani pastoralists through the addition of leaf extract of Sodium

apple (*Calotropis procera*), until recently, when the use of *Carica papaya* (pawpaw leaf) and lemon juice was demonstrated (Adetunji *et al.*, 2008).

3.0 Processing steps for cheese production

Soy cheese making has close resemblance to that of cow milk cheese production in terms of biochemistry, microbiology and processing technology. Even the final products have great similarities in appearance, texture and chemical constituents. The processing of the soy cheese started by soaking the soybeans in water for 12-14 hours (Tofu, 2013) after which the soybeans was dehulled, grinded and mixed with water. The milk was separated from the mixture with the use of sieve to separate the soymilk from the chaff. The milk was boiled (pasteurized) and allowed to cool while the coagulant (Lemon juice) was added to the separated soy milk to form curd which was pressed to remove the water present in the curd. The hardened cheese was cut and packaged as soy cheese (Tofu, 2013).

In the production of cow milk cheese a fresh whole milk is used. The fat content of the milk was reduced by keeping the milk settled for about one hour then the top layer was skimmed off (high fat milk or cream). The milk was heated to about 85°C to destroy most of the bacteria present and also to increase yield through precipitation of the whey proteins (Adetunji *el at.,* 2008), Lemon juice (Coagulant) was diluted with an equal quantity of clean, fresh water so that the lemon juice can be distributed uniformly. About 30 ml of lemon juice per litre of milk was added and stirred while carefully adding the lemon juice.

The curd precipitated almost immediately. Stirring continues for about three minutes after adding the lemon juice and then the curd settled for 15 minutes. The curds are separated from the whey by draining through a sieve or a muslin (cheese) cloth. While draining the whey, the curd was stirred to prevent excess matting (Adetunji *et al*., 2008). Salt was added to the curd at a rate of about 4 g for every 100 g of curd and mixed properly. The quantity of salt may be varied to cater for consumer taste preferences. The curd is transferred to a mould (container) lined with muslin (cheese) cloth. The curd was wrapped with the muslin (cheese) cloth and a wooden follower is fitted neatly inside the mould to enable the curd to be pressed (Adetunji and Babalobi, 2011).

The curd was pressed overnight by placing metal weights on top of the wooden follower; the cheese was cut into suitably sized pieces for sale. The cheese can be coated with a thin film of butter to enhance the appearance. Figure I show a flow chart of the steps in the production of cheese and the plates also show some of the processes and materials used in cheese production.

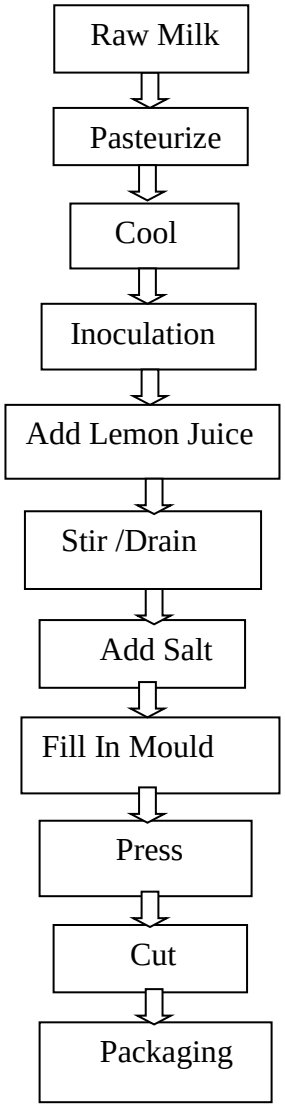

Figure 1: A flow chart of cow milk cheese production.

4.0 Nutritional properties of cheese

The nutritional and proximate analysis of the cheese revealed that it contains vital components of balanced diet such as protein, fat, minerals, vitamins and essential amino acids (Adetunji *et al.*, 2008; Oladipo and Jadesimi, 2012). Recent advances in nutrition science have highlighted the contribution of cheese to nutrition and health. Cheese is a rich source of essential nutrients; in

particular, proteins, bioactive peptides, amino acids, fat, fatty acids, vitamins and minerals. Ripened cheese is free of lactose and therefore suitable for the nutrition of lactose-intolerant individuals. Peptides were also detected in specific cheese varieties in significant quantities (Bucher *et al*, 2008). The high concentration of essential amino acids in cheese contributes to growth and development of the human body (Fabiyi, 2006).

Despite the presence of a notable amount of saturated and trans-fatty acids, there is no clear evidence relating the consumption of cheese to any disease. Conjugated linoleic acid and sphingo-lipids present in cheese may have anti-carcinogenic properties. The high concentration of calcium in cheese is well known to contribute to the formation and maintenance of strong bones and teeth, but also shows a positive effect on blood pressure and helps in losing weight in combination with low-energy diets. Cheese is an important dairy product and an integral part of a healthful diet due to its substantial contribution to human health. Warsama *et al* (2006) reported that Sudanese white soft cheese contained 47.8% total solids, 14.0% fat, 15.9 % protein and 6.2% ash , and it is locally known in Sudan as Gibna Bayda and it is usually stored in containers filled with whey. Natural cheese should be stored at suitable temperatures to ensure good quality because a high temperature leads to evaporation of moisture and growth of unwanted bacteria and other faults (Ramakant, 2006).

5.0 Shelf life of cheese

The shelf life of cheese without preservative addition is just in few days when evident spoilage would be observed. In contrast, cheese with preservative showed a longer shelf-life taking into account the moisture content of the product (cheese). So, additives act as effective preservative against molds and yeasts, with some effectiveness against bacteria in agreement with reports of Brocklehurst and Lund, 1999. Besides, the preservative activity is directly linked to changes in pH, and this parameter showed slight changes during storage. In effect, minor variations in pH and acidity, may be related to amino acids and free fatty acids being produced during proteolysis and lipolysis, respectively (Dermiki *et al*, 2008).

Generally, harder (lower moisture) cheeses keep longer than softer (higher moisture) cheeses. However, the reduction in shelf-life and public health risk associated with microbial

contaminants of West African cheese has been reported in literature (Adetunji *et al.*, 2008; Oladipo and Jadesimi, 2012). The microbial contaminants are introduced into the cheese through the use of unsterilized containers, handling and contamination of the milk by the plant extracts (Adetunji and Babalobi, 2011).

6.0 Preservative techniques of cheese

1. Refrigerating

Cheeses have only a short shelf life and lose quality rapidly if exposed to warm temperatures during storage. Refrigeration can substantially reduce the rate at which cheese deteriorate, low temperature slows down the growth of microorganisms and the rate of chemical changes in cheese (Shurtleff, 2000). Soft cheese can be stored by refrigeration for up to 2-3 weeks while cottage cheese can be refrigerated for 10-12 days due to its high moisture content (75%) and a relatively high pH (5.0). Cheeses have limited shelf life when refrigerated because refrigeration only slows bacterial growth and does not prevent it (Oladipo and Jadesimi, 2012). Additionally, cheeses have a higher warehousing and shipping cost due to the need to maintain proper refrigeration.

2. Addition of preservatives

The addition of preservatives during the process of cheese production prolongs its shelf life by reducing the effect of spoilage microorganisms on the cheese. Some of the common preservatives of cheese include:

(a) Nisin: Nisin is a bacteriocin widely used as a food preservative particularly in cheese (Deegan *et al*, 2006; Delves-Broughton, 2005). In the cheese industry, the use of nisin in free form, such as nisaplin is costly and has drawbacks, including lower activity, stability and bioavailability. Moreover, free nisin may interfere with cheese-making process or reduce cheese quality by inhibiting the starter culture or nonstarter lactic acid bacteria which is important in ripening and flavor development (Buyong *et al*, 1998). There has thus been continued interest in developing other means of incorporating nisin into cheese, such as the use of a mixed starter culture containing a nisin producing strain. Since most starter cultures show variable sensitivity to nisin (Rada and Dlabal, 1998), nisin-producing strains should be combined with nisin resistant or tolerant starter culture to ensure a proper balance between lysed and intact cells (Benech *et al*, 2002).

(b) Curcumin microcapsules: Curcumin is a pigment which can act as both a natural colourant and a preservative for food due to its antimicrobial effects (Wang *et al*, 2012) when preserving cheese, curcumin is added after heat treatment of the cheese, and studies have shown that mold growth was eliminated.

(c) Ocimum sanctum: ocinum sanctum is a natural preservative in cheese, contributing to the storage of cheese. Generally, after a week of storage, cheese protein will loosen and water absorption will increase to about 5%. However, ocimum sanctum minimizes this water absorption to 1%. The application of this preservative also allows the cheese to be stored without refrigeration for more than 7days (Anbarasu *et al*, 2007).

(e) Chitosan: Chitosan is effective in inhibiting the growth of spoilage microorganisms such as coliforms and *Pseudomonas* spp. Moreover, it seems that the presence of chitosan does not affect the growth of lactic acid bacteria, saving the functional dairy (Altieri *et al*, 2005). Addition of bioactive lipophilic compound to cheese milk can prolong the shelf life of product but high losses in whey can be obtained (Banville *et al*, 2000). To overcome this problem, immobilization method is necessary. The encapsulation of bioactive ingredients in cheese under the form of emulsified particles allows the increasing retention in the curd, hence maintaining bioactivity and the chemical stability of cheese during storage, with improved cheese yield (Stratulat *et al*, 2014).

3. Use of modified atmosphere packaging (MAP)

The use of modified atmosphere packaging may reduce contamination levels but the sensory characteristics and evolution throughout the storage time are also important. Some authors have pointed out the adverse effects of carbon dioxide on sensory characteristics. The potential of modified atmosphere packaging for extending commercial life of cheese has been clearly demonstrated, although cheese packaging is dependent on the type of cheese, the starter used during manufacturing is also a very important parameter (Gammariello *et al*, 2009).

The use of protective atmospheres made up of 100% N or 100% CO has often proved unsuitable for packaging of hard or semi-hard long ripened cheeses such as Cheddar cheese (Colchin *et al*., 2001), Parmigiano Reggiano cheese (Romani *et al*, 1999) and Samso cheese (Juric *et al*, 2003). It does not guarantee an optimal preservation and negatively influences the product's organoleptic characteristics, thus making use of different mixtures of the two gases is preferable. Conversely, carbon dioxide concentrations ranging from 10-50% have given interesting results

both for preservation and for sensory characteristics of several dairy products, such as Cottage cheese (50% CO) (Fedio *et al*, 1994), Parmigiano Reggiano cheese (30% CO) (Romani *et al*, 1999).

4. Use of high pressure

Evert-Arriagada *et al*. (2014) evaluated commercial application of high-pressure processing for increasing fresh cheese shelf-life. The effect of 500MPa on physio-chemical, microbial, color, microstructure, texture and sensorial characteristics of fresh cheeses during cold storage of 21 days was studied. The results showed that pressurized cheeses presented a shelf-life of about 19-21 days when stored at 4°C, whereas control cheese became unsuitable for consumption on day 7-8. On the other hand, cheese treated at 500 MPa was firmer and more yellow than the untreated one. However, these changes which were detected by instrumental and sensory analysis, did not affect the preference for pressurized cheese. These results may lead to practical applications of high processing pressure in the food industry to produce microbiologically safe cheese with extended shelf-life and sensory quality.

5. Freezing of cheese

The basis behind making frozen cheese is to apply cold temperature and drying methods to increase its shelf life. Once the cheese is coagulated, cut and pressed, it is allowed to freeze at a temperature of approximately -10^0C. Cheese is stored in the freezer until it is completely solid. The frozen cheese is stored at -3^0C for 20 days and then thawed by spraying with warm water (Shurtleff, 2000). The thawed cheese is pressed to remove excess water before the final drying. Hot air is blown on the cheese until it is dried. This process takes about two hours to complete. The cheese can be stored for up to eight months and up to one year if refrigerated (Shurtleff, 2000).

6. Aseptic packaging

In order to increase the shelf life of cheese, aseptic packaging is an effective method (Lum, 1999). The milk used in the cheese production is treated with ultra high temperature of around 140^0C (Troeger, 2013), briefly for sterilization and the cheese container is sterilized by going through a 30% hydrogen peroxide bath at 70^0C for six seconds. The sterile environment is then achieved through hot air and steam. After the coagulant is added to the milk, the package is sealed and then heated to around 90^0C (Troeger, 2013) to help the cheese solidify.

7. Deep Frying Method

Cheese can be deep fried, which involves heating it in oil at a high temperature. The hot oil causes water in the cheese to evaporate. This phenomenon leads to the drying of the cheese, replacing the water content with oil. The decrease in water activity and increase in the oil content will enable the extension of the storage life of cheese, since microorganisms require free water in order to carryout chemical and biological reactions, helping them survive and multiply (Chan and Judy, 2013). With proper packaging and refrigeration, deep fried cheese could be stored up to about one month**.** Although lowering the water content will minimize the risk of bad microorganisms in cheese, the high fat content of deep fried cheese could also be harmful to health by increasing the risk of cardiovascular disease upon consumption.

8. Freeze drying method

Freeze-drying is the drying method that gives final products of the highest quality compared to other drying methods. Due to the absence of liquid water and to the low temperatures required for the process, most deterioration reaction rates are very low, which gives an excellent quality final product. The solid state of water during freeze-drying, with restricted movement in comparison to liquid water, protects the primary structure, and preserves the original structure and the shape of the food material with minimal reduction in volume. During freeze drying, cheese is placed in a chamber at a temperature around -30^0C. The chamber is been pressured to 0.3atm and the ice is heated by raising the temperature. The ice begins to sublime leaving the cheese behind (Amano, 2013). There will be no change in the texture, taste or flavour of the freeze dried cheese and it will appear to be a freshly made cheese once water is added (Amano, 2013). Freeze drying involves the removal of water or other solvent from a frozen product by a process called sublimation. Sublimation occurs when a frozen liquid goes directly to the gaseous state without passing through the liquid phase.

The freeze dried cheese can be eaten directly in form of a snack or used as a source of protein for soup. Because the cost of the specialized equipment required for freeze drying can be substantial, the process may appear to be an expensive undertaking. Freeze drying is therefore more convenient and easier as it does not require freezing conditions during distribution. Although

freeze drying is the conventional drying technique used commercially by some cheese manufacturers, it is more expensive than other drying processes (Fonseca *et al* 2001).

7.0 Problems of cheese preservation in Nigeria

Adeneye (1999) listed the various factors responsible for the inadequacy in the dairy industry in Nigeria as follows:

(i) Poor genetic quality of natural herd which affects the quality of milk produced.

(ii) Lack of input supply and credit to cheese producing enterprises.

(iii) Inadequate infrastructure for cheese production.

(iv) Inadequate understanding of existing small scale cheese production systems.

(v) Lack of trained man power for processing and production of cheese.

The Fulani are the majority in the production of cow cheese in Nigeria, bare hands and unsterilized containers are used for its processing. The Fulani use dirty water from rivers and streams to dilute the milk, this lapses in hygienic practices result in milk-borne diseases. More so, milk from cows that have had intensive veterinary care may contain high doses of veterinary drugs, especially after immunization (Akinwumi, 2008). Unfortunately, Nigeria seldom tests for drugs or inspects dairy products from local herds and dairy plants. Traces of these chemicals, therefore, may be high enough to pose potential dangers to human health.

One of the major factors limiting the productivity of operators in the small scale diary enterprise in Nigeria is their low literacy level, which might make it difficult for them to fully appreciate the need to adopt improved milk processing and handling techniques (Igwe, 2002). The skills and management capabilities needed for successful modern cheese production in Nigeria is very low. The problems experienced by dairy sector are similar to those experienced by all other sector, inadequate management, political interference (concerning milk prices), low productivity, poor financial performance and poor preservative techniques (Tahir, 1999).

The cheese industry in Nigeria is faced with logistical problems. The inefficient method of collection and distribution of milk hinder cheese development. Milk producing areas are in the remote areas that are not accessible by road. The lack of access roads and specialized vehicles necessitate the delivery of milk by foot (Akinola, 2003). Transportation by foot is obviously slow

and this affects cheese production, it may spell the difference between business success and business failure. The Fulani cannot deliver the milk to the processing centers within the critical four hours after milking (Igwe, 2002). More than half of the milk gets spoilt before getting to the cheese production center. The bulk of the labour input in the small scale cheese processing enterprise is supplied by family labour. The availability of labour is therefore directly related to the family size.

In Nigeria, there is no organized structure and proper management system in the cheese industry. The efficiency of an industry, which is an element of performance, may be related to the industry's structure and conduct (Olufokunbi, 1999). Most of these firms cannot get the minimum one thousand liters of wholesome, liquid milk per day. To supplement periodic shortages of milk and to keep the plants running, some cheese industries import powdered milk and use it in processing. Some plants even breed their own high-yielding milk cows.

The cost per liter of the milk from these firms is however so high that the industries operate at a loss. The industries fold up frequently due to the inability to compete in a price-sensitive market place. But the real cause of the failure of state-owned dairy farms is that the government's goal is not in tandem with commercial objectives (Tahir, 1999). In other words, governments objective may not necessary be profit-making. Like most government ventures, state-managed dairy plants in Nigeria are set up as service industries to create jobs, silent political agitation, or impress a constituency for future voter reward.

7.0 Ways forward to cheese preservation in Nigeria

Nigeria has the potential of being a major cheese producer in Africa. Output can be raised substantially for internal use; as well as for export because Nigeria is the largest producer of cow milk in West Africa and the third in Africa (Michael *et al.*, 2000).

Akinola (2003) suggested that for a successful and efficient cheese processing enterprise to be achieved, there must be proper selection of dairy cattle, adequate feeding and regulated milking of the cattle coupled with an appropriate processing technique. If the Nigerian dairy industry was

to meet the high demand for dairy products, the concept of village technology, which is based on the existing techniques, must be adopted and improved upon by cheese production enterprises.

Tahir (1999) hinged the inability of the dairy industry to meet the demand of the country for cheese and other milk products on the neglect of the industry by the government through the lopsided distribution of resources within the agricultural sector. Akinwumi (2008) on the other hand, focused on the economics of the cheese production in Nigeria. Since education is of great importance to agricultural development, the Nigerian government is making frantic efforts to reduce the high illiteracy level prevalent among the nomads. One of such efforts is the establishment of the nomadic education programme to cater for the educational needs of these important pastoralists (Igwe, 2002).

The government has now realized the importance of small, backyard dairy firms who use family labor in sustainable and affordable milk production in Nigeria. These cottage producers are using local skills and less energy-dependent methods. In the second livestock development program, the government plans to make these small-scale industries the center of cheese production in Nigeria (Akinola, 2003). To this effect, the government is privatizing the remaining cheese ventures and encouraging commercial ranches to supply the milk.

8.0 Conclusion

Cheese preservation techniques which include modified atmosphere packaging, refrigeration, pressure system, use of additives, deep frying and freeze drying all have one demerits or the other. The modified atmospheric pressure system which can be used for preserving cheeses but temperature control and selection of proper packaging material is important. The addition of preservative can prolong shelf life of cheese but in selection of proper additive, sensory properties of special cheese and dosage of additives must be considered.

Although High pressure method can inactivate parasites, vegetative microorganisms, some fungal spores, many food borne viruses and enzymes, the use of special equipment made it expensive. On the other hand, applying High pressure in small plants is not feasible. Active and edible coating in order to prolong cheese shelf life has been increased in recent years but due to

diversity of cheese and subsequent difference in properties, the design of packaging system to each cheese must be specialized. Deep frying method increases the fat content of cheese thereby increasing the risk of cardiovascular diseases. Therefore, freeze drying with its obvious advantages is considered to be preferably the most effective preservative technique for cheese.

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