Chapter 11
Quality Evaluation of Semi-Indigeous Proceesed Cheese (*Gibna-Beida*) in Sudan

Walied Abdelrahman Mustafa, Onaheid Ahmed Osman, and Abdel Moneim Elhadi Sulieman

11.1 Introduction

Sudan assumes the top place among the countries of Middle East regarding the animal wealth and rank the second in Africa. Within the animal resource sector, the largest component is estimated 133.640.00 heads: cattle 39.667.000, sheep, 48.440.000, goat, 42.030.000 and camel 3.503.000 heads (MRF 2003). According to Federal Ministry for Animal Resources Fishery and Range (2012), the livestock population in Sudan was estimated to be about 29.618.000 cows, 39.296.000 sheep, 30.649.000 goats and 40.715.000 camels the total is 140.278.000 head. The indigenous herds found in Sudan belong to the Zibo group in northern Sudan (Sudanimals 2007). Examples are Butana, Kenana and Baggara; multipurpose breeds that are used for milk and meat production as well as draught power (Payne and Hodges 1999). The Butana cow is considered the best milk producer of the Sudanese Zebu breeds (Sudanimals 2006).

11.2 Milk Production in the Sudan

The milk production in the Sudanese indigenous cattle breeds Kenana and Butanna (*B. indiucs*) was found to be lower than that of Holstein Friesian cattle (*B. Tarurs*), even under the same climatic conditions (average lactation milk yield 1405 ± 695 kg

W. A. Mustafa (✉) · O. A. Osman
Department of Food Science and Technology, Faculty of Agriculture, University of Bakht Alruda, Eldoeim, Sudan

A. M. Elhadi Sulieman
Department of Biology, College of Science, University of Hail, Hail, Kingdom of Saudi Arabia

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compared to 4784 ± 81 kg in Holstein Friesian) (Ageeb and Hillers 1991; Ageeb and Hayes 2000). Low productivity (total lactation milk yield: 1597 kg) was also shown in another study concerning the Kenana breed (Wilson 1984). However, the same authors suggested that with improved management, feeding and breeding, the Kenana breed has a high potential as a milk producer under tropical climatic conditions.

The available estimate of milks production in the Sudan vary widely and no accurate statistics are kept. It has been estimated in 1982, 2.9 million tons of milk was produced of which 2.5 million tons (82% were cows milk, the bulk of which is in the hands of the nomadic tribes. The annual production of milk obtained from cows, sheep, goats and camels is estimated at 20249.91 million tons (AOAD 2002).

A great proportion of milk produced in the world is converted into skimmed milk and fermented milk products like cheese and yoghurt that can be kept for longer periods without cooling. Milk is an in dispensable food item and is considered as nature's perfect food for human beings as well as other animals. Mammals secretes milk for the nourishment of their young ones and milk of animals like cattle, buffalo, goat, sheep, camel, yak, etc. are being used as food for human beings (Van Soest 2018).

11.3 Milk Composition

Milk is approximately 87 percent water and 13 percent solids. Milk fat carries the fat soluble vitamins A, D, E, and K (Hurley 2015). The solids-not fat consists of protein, lactose, and minerals. Milk also contains other water soluble vitamins (Mehta 2015). Federal definitions and standards of identity specify the minimum levels of milk fat and solids not- fat for the various milks shipped in interstate commerce (Vaclavik and Christian 2014). Fat gives milk its characteristic smoothness, flavour and colour. Milk fat contains about 66 different fatty acids, emulsified and dispersed in water in small globules. All the essential amino acids are found in milk protein. Eighty percent of milk protein is casein which is found in combination with calcium and phosphorus. The other important milk proteins are lactalbumin and lactoglobulin (whey proteins) (Payne 1990). Lactose is the most stable component of milk.

11.4 Fermented Milk

Fermented milk was warm, raw milk from cow, sheep, goat, camels or horses of the nomads roaming the area, which was turned, into clabber, or curd by bacteria and their end products. Fermentation process, which occurs in fermented milk, results in conversion of lactose to lactic acid. This acid has a preservative effect on milk. The low pH of fermented milk inhibits the growth of undesirable bacteria and pathogenic organisms. The starter cultures used for fermentation of milk convert a part of lactose to lactic acid, carbon dioxide, acetic acid, acetaldehyde and several other materials (Walstra et al. 1999).

Fermented milk foods with desirable characteristics of flavor, texture, and probiotic profiles can be created by formulating the desired chemical composition of the milk substrate mix, judicious selection of lactic acid bacteria (starter), and fermentation conditions (Chandan 2014). A starter is made up of one or more strains of food-grade microorganisms. Individual microorganisms utilized as a single culture (single or multiple strains) or in combination with other microorganisms, exhibit characteristics impacting the technology of manufacture of fermented milks. Fermented milks have long been used as the main vehicles for probiotic strains. The supplementation of cheeses with probiotic bacteria represents the aggregation of added value to a product that already has benefits inherent in its composition (Balthazar et al. 2017; Gomes et al. 2011).

11.5 Starters

A starter is a culture of one or many types or strains of lactic acid bacteria that is added to milk to ferment it. Sometimes the inoculum also contains no-lactic acid bacteria, whereas in other cases the latter are added separately to the milk. Traditionally, a starter is obtained via growth of lactic acid bacteria in milk at a suitable temperature. The starter is subsequently maintained by propagating and growing it in a fresh portion of milk. Currently, special growth media rather than milk are also utilized to avoid multiplication of bacteriaphages during starter manufacture (Axel 1998).

11.5.1 Properties

The biochemical conversion of milk components by lactic acid bacteria naturally causes changes in the fermented products. These changes depend on the properties of the starter bacteria involved and on the type of product made. The followings are the main aspects:

1. **Production of acid from lactose:**

   The production affects of the preservation of the product, the texture of the product and the flavour of the product.

2. **Formation of other compounds during the fermentation of lactose and citric acid:**

   - Flavour compounds: They involve several metabolites, diacetyl in particular. The desired types of aroma bacteria present in such starters may vary. In aromatic starters, the ratios between the bacterial strains involved are very critical with respect to the formation of diacetyl from citric acid.

- Carbon dioxide: The production of CO_2 by aroma bacteria is essential for the texture of cheese in which the formation of few “eyes” is desirable like Gouda cheese.
- Bacteria exopolysaccharides: The consistency of stirred yoghurt greatly depends on the strains of bacteria used, and the exopolysaccharides produced by them are held to be responsible.

3. **Proteolysis: Protein degradation affects**:

- The consistency of the product.
- The flavour of the product.
- The mutual growth stimulation of lactic acid bacteria.

4. **Lipolysis:**

The formation of fatty acids is important for flavour of ripened cheese. Hydrolysis of fat during storage is undesirable for products that are consumed shortly after manufacture. Most of the lactic acid bacteria cannot hydrolyze triglycerides, but they can hydrolyse mono- and diglycerides; hence, they can enhance ongoing hydrolysis of fat. Therefore, the conversions by lactic acid bacteria strongly determine shelf life, safety, consistency, and development of flavour and texture of fermented products. The selection of a starter must be based on the properties desired in the product to be made.

11.6 Cheese

Cheese is a product that 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 (Guinee and Fox 2017). Fox et al. (2000) defined cheese as the fresh or ripened product obtained after coagulation and whey separation of milk, cream or partly skimmed milk, butter milk 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 2000). Each type of milk imparts the characteristics quality of cheese made from it and the resulting cheese will diver in its proprieties, body texture, and flavor (Andrew 2010). The annual reports of Federal Ministry of Animal Resources (FMAR) 2001 pointed that the total annual production of cheese in the Sudan was (650) thousand metric tons (Sambo 2009).

The cheese industry in Sudan is spread in the rural areas with rich resources in large livestock. Most of these areas are located around cities in small villages that lack electricity and depend on water sources to harvest rainwater and store it in large pits around the village, as well as water wells of groundwater with high salinity. Most of the white cheese factories that depend in production process on primitive tools. This is an industry that is continuously inherited from grandparents to children and grandchildren. Therefore, white cheese in Sudan is an important traditional industry that competed with the big companies when they introduced technological methods in their production.

11.6.1 Muddafara Cheese

Muddafara cheese was manufactured traditional from both types of milk and from a mixture of the two types. The samples were then ripened in an incubator (40 °C) for 35 minutes before addition of rennet at a rate of 0.07 g/l at the same temperature. After complete coagulation, the curd was cut into small cubes and was salted at 40o until the required acidity for kneed ling was reached (0.46–0.60%). Ripening was assayed by teasing the ability of the curd to be kneed led into a 4-metre rope while any breakage before this length was reached would indicate inadequate ripening. Whey was drained from the ripened curd which was then placed into a wooden plate and cut into slices. The curd was cooked in water at 75%C for 5 minutes and then black cumin (Nigella Sativa) was added to the curd which was then hand-kneed led and pulled to from a long rope. This was washed and left for 48 hours at room temperature in salted whey (10% v/v NaCl) (Suleiman et al. 2005). According to Suleiman et al. (2005) Muddafara cheese content 33% moisture, 1.2% ash, 26% fat, 4.6 total nitrogen, 24% total protein, 42% soluble nitrogen, 41% total solids, 0.88% titrable acidity. pH 5.39 and yield 12.4 kg/100 liter milk.

11.6.2 White Cheese (Gibna-Beida)

White Cheese (Gibna-Bayda) is practically the only kind of cheese on the market available to the public at large in the Sudan and is thus normally referred to simply as jibna-beida. Many Sudanese think that the product is truly indigenous fermented food of the Sudan, but this contention has no basis. It is believed that the beginning of the white cheese industry in Sudan for the first time was by a Greek family, Catherine and Banyuti Maestro, who settled in 1908 in the town of El-Dueim, on the White Nile, 225 km south of Khartoum, and who established in 1920. The first cheese factory dedicated to commercial production (Ali 1987) (Fig. 11.1).

Manufacture of Jibna-Beida

The white cheese industry begins with receiving milk from shepherds in the early morning hours and it is emptied into large plastic barrels with a capacity of 470–500 lbs. After that, coarse salt is added directly to the milk by 18–20 kg and stirred for a period to ensure its dissolution, followed by the addition of the resonance enzyme at a rate of 2–3 strips one barrel, then cover the barrel and Leave until frustration is complete within 6–8 h (Fig. 11.2).

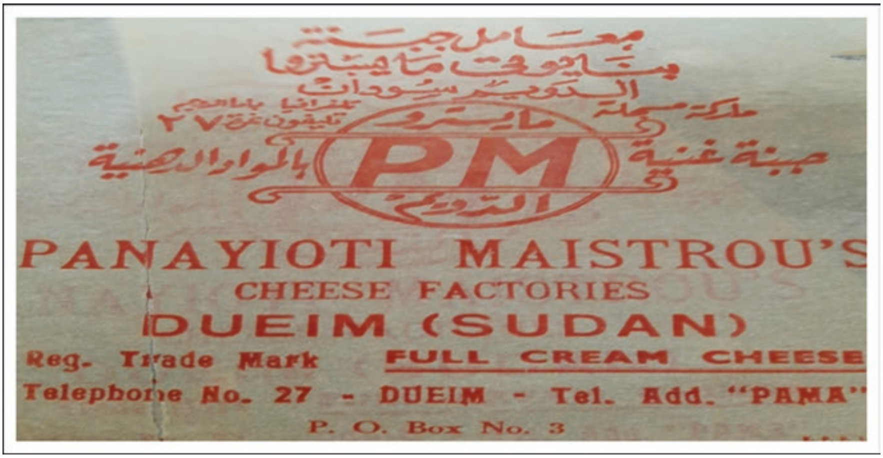

Fig. 11.1 Explains the first preamble to the white cheese product by the Greek Maestro Baniotti in the city of El-Dueim in 1953

Fig. 11.2 Explain Preparing the salt, filtering the milk on it and stirring to dissolve it, then preparing the starting and adding it with stirring again to make the mixture homogeneous

After the frustration period ends, a cleaning process begins on the upper surface of the curd by excluding all the impurities on the surface from the remains of insects and animal dung from the milk during the milking process, as well as extracting the fatty layer on the surface of the curd and storing it and producing margarine (Semin) from it as a by-product of the manufacture of white cheese.

This is followed by cutting the curd with plastic containers, which are then used to transfer the curd to wooden boxes, with plastic sacks (strainers) underneath, to filter the water from the curd. Wooden boxes are used to form white cheese into large rectangular shapes. After completing the filling of the wooden boxes, the curd is moved with your hands to filter part of the water to add another amount of coagulated milk to ensure that the box is filled with the largest amount of coagulated milk.

Fig. 11.3 Explain the purification and extraction of fat in top of coagulate

Fig. 11.4 Explains the process of filling wooden boxes and the process of preliminary filtering of water by stirring with hands

After that, the curdled milk is left inside the boxes after covering it for the next day (overnight) (Figs. 11.3, 11.4 and 11.5).

Finally, the filling process of white cheese is done in plastic containers, and the product takes square shapes of semi-equal sizes, then the salted water resulting from filtering is added so that the whole product is covered. The packages weighing 11 kg will be reduced to about 9 kg after ripening within 7–10 days (Fig. 11.6).

11.7 Chemical Composition of White Cheese

The chemical analysis of collected Gibna-Bayda samples collected from different area showed in Fig. 11.7. The moisture content of cheese samples ranged between 53.27 ± 0.262% and 57.83 ± 0.127% with an average value of 55.83%. There was

Fig. 11.5 Explain cutting the curds and placing them in storage containers, then adding a portion of whey water for ripening and preservation

Fig. 11.6 Explain forms and packaging of white cheese produced

significant variation ($P \geq 0.05$) between collected cheese samples in moisture content. The protein content of cheese ranged with an average value of 14.57%. And statistically, there were no significant differences between the samples collected except for sample D, which was significantly different ($P \leq 0.05$). The fat content of cheese samples ranged with an average value of 20.84%. Statistical analysis showed significant differences ($P \leq 0.05$) in fat content of collected cheese samples except samples A and B. The difference in the fat content can be attributed to several factors such as the animal's nutrition, individuality of animal, health and age of the animal when the milk was taken. The ash content of cheese samples ranged from 3.77 ± 0.012% to 5.60 ± 0.087% with an average of 4.45%. Statistically no significant difference ($P \geq 0.05$) was found in the ash content of the various cheese samples except samples C and F. Lactose content of cheese samples varied from 1.19 ± 0.000% to 5.77 ± 0.035% with an average of 4.31%. However, significant ($P \geq 0.05$) variations were found in lactose content of the cheese from different cheese samples. The total solid of cheese samples varied from 42.17 ± 0.012% to 46.73 ± 0.064% with an average of 44.17%. Statistical analysis showed significant differences ($P \leq 0.05$) in total solids content of different cheese samples. The variation in total solids content might be due to the lack of standard procedure followed by producers. Solid non fats (SNF) content of cheese samples varied from 20.33 ± 0.144% to 24.60 ± 0.046% with an average 22.01%. Statistical analysis showed significant differences ($P \leq 0.05$) in solid non fat content of different cheese samples. Also Fig. 11.8 showed that pH values of cheese samples varied between 3.9 ± 0.000 and 6.0 ± 0.058 with an average of 5.0. There were Significant differences ($P \leq 0.05$) in pH values of cheese in different samples. The range of titratable acidity of the collected cheese samples varied between 1.21 ± 0.006 percent to 2.06 ± 0.100% with an average of 1.57%.

11.8 Mineral Contents of Collected Chesse Samples

Figure 11.9 presents the mineral content of different cheese samples collected from different area. The analysis of cheese samples for minerals reflected high concentration of most minerals especially macro-elements sodium, potassium, calcium, lead and phosphorus with an average value of 244.8, 63.07, 458.25, 0.52 and 97.35 ppm, respectively, whereas most micro-element manganize, iron and zinc was very low in cheese samples, with an average value of 0.05, 0.50 and 6.56 ppm, respectively.

11.9 Microorganisms Associated with Cheese

Microbiological characteristics of the collected cheese samples are shown in Table 11.1. The total bacterial count (TBC) varied between $4.5 \times 10^5 \pm 1.048$ and $41.0 \times 10^5 \pm 17.786$ cfu/g with an average of 18.76×10^5 cfu/g. Statistical analysis showed that there were significant difference ($P \leq 0.05$) in total bacterial count of the collected cheese samples. The average lactic acid bacterial count (LAB) of cheese samples was 3.49×10^5 cfu/g. The coliform were not detected in cheese samples (A, B, C and D), whereas, it was found in cheese samples F (23 cfu/g). The

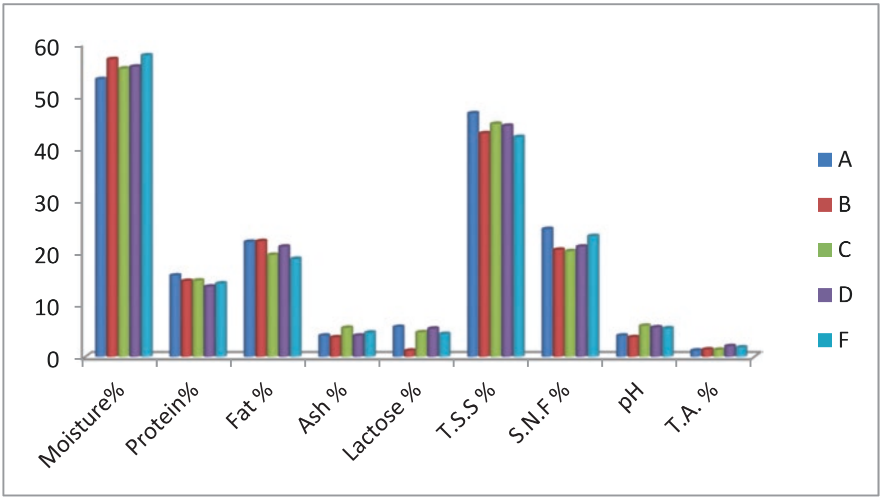

Fig. 11.7 The chemical analysis of collected Jibna-beida samples from different area

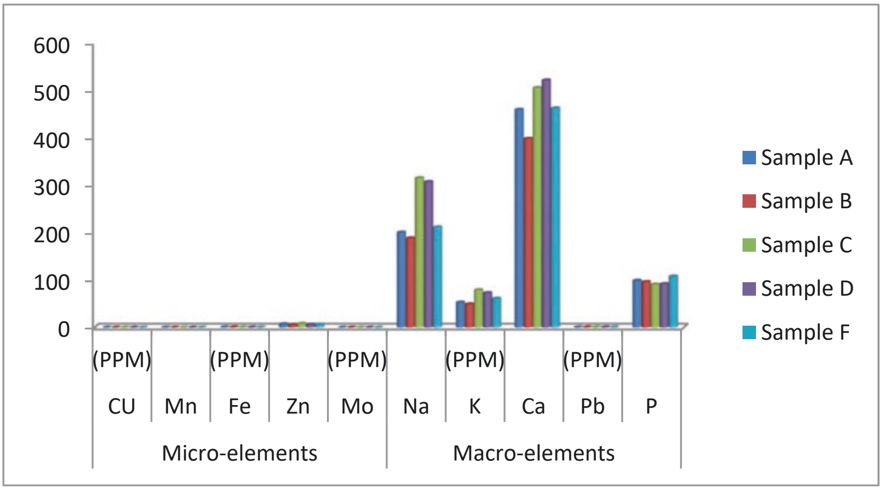

Fig. 11.8 The mineral content of different cheese samples collected from different area

absence of coliform in the different cheese samples could be attributed to the salt added in the processing. The presence of coliform cells in cheese sample F was probably due to milking and production of cheese under poor condition (Ceylan et al. 2003; Warsma et al. 2006). According to the international standards, white cheese should not contain more than 100 cfu/g coliform bacteria (Lau et al. 1991). The result shows the absence of *Salmonella* in cheese samples (A, B, C, and D), while, sample (F) showed positive result. The presence of *Salmonella* will create health risks to the cheese consumers, and when consumed, can cause symptoms

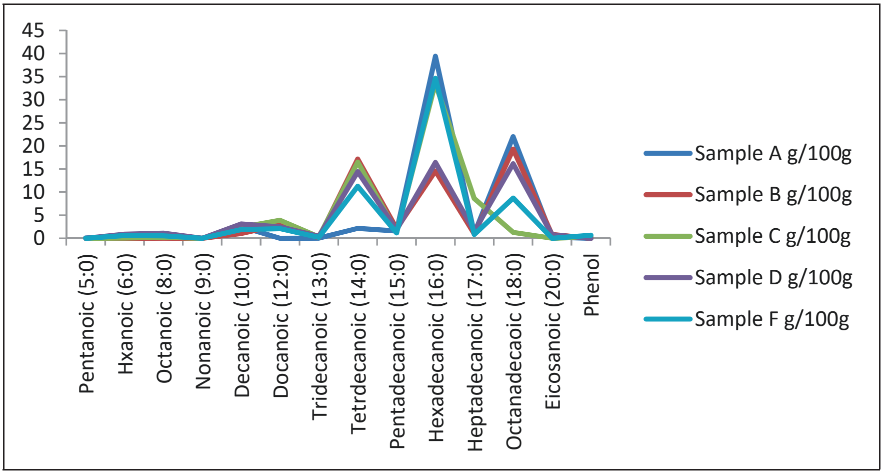

Fig. 11.9 Show Saturated fatty acids composition of jibna-beida samples obtained from different area

such as diarrhea, stomach pains, nausea and vomiting and stomach infections. In very serious case, it can cause death. On the other hand the absence of Salmonella in the other cheese samples examined probably due to high levels of salt and titratable acidity. The high count of *staphylococcus aureus* found in some cheese samples might be attributed to the high initial numbers of *staphylococcus aureus* in milk contamination during processing (Santos and Genigeorgis 1981). The yeasts and moulds cells were detected in all cheese samples with an average count was 4.47×10^4 cfu/g. Statistical analysis showed that there were significant differences at ($P \leq 0.05$) in yeasts and moulds count of different cheese samples. The high count of yeasts and moulds in the cheese samples indicates poor hygienic conditions.

11.10 Packaging

Packaging or packing of cheese is one of the more important steps in the long journey from the producer to the consumer, since most of the cheese plants are far away from the consumption. Packaging of natural cheese must afford general protection of the product from mechanical damage and poor environmental conditions during handling and distribution (Abdalmagid 2019). Also may prevent moisture loss, improve appearance, protect against microorganisms, and prevent oxygen transmission, also may serve as a marketing tool, which provide useful information about the producer name, brand size, variety, net weight, count, shipper and country of origin (Ghemawat et al. 2003). What is noticed in the traditional white cheese industry in Sudan is the use of traditional and recycled packages with the intention of reducing the costs of production by manufacturers and their lack of knowledge of

Table 11.1 The microbiological characteristics of Sudanese cheese Jibna-beida samples

Sample	Total viable count of bacteria (cfu/g)	Coli-form MPN index per gram		Yeast and mould (cfu/g)	*Staphylococcus* (cfu/g)	Detection of Salmonella	Lactic Acid Bacteria (cfu/g)
		Total	*E.Coli*				
A	$41.00 \times 10^{5a} \pm 17.786$	0	0	$5.80 \times 10^{4ab} \pm 1.453$	$5.27 \times 10^{2ab} \pm 2.021$	-ve	$6.67 \times 10^{5b} \pm 0.811$
B	$4.53 \times 10^{5b} \pm 1.048$	0	0	$7.00 \times 10^{4a} \pm 1.562$	$5.30 \times 10^{2ab} \pm 1.877$	-ve	$45.00 \times 10^{5a} \pm 15.044$
C	$6.00 \times 10^{5b} \pm 1.155$	0	0	$4.67 \times 10^{4b} \pm 0.811$	$5.00 \times 10^{2ab} \pm 0.577$	-ve	$41.67 \times 10^{5a} \pm 13.956$
D	$5.28 \times 10^{5b} \pm 1.525$	0	0	$0.43 \times 10^{4c} \pm 0.079$	$6.00 \times 10^{2a} \pm 0.577$	-ve	$5.63 \times 10^{5b} \pm 1.880$
F	$37.33 \times 10^{5a} \pm 5.812$	23	11	$4.47 \times 10^{4b} \pm 0.786$	$3.80 \times 10^{2b} \pm 1.348$	+ve	$4.28 \times 10^{5b} \pm 1.748$
Error mean square	5.53	–	–	2.04	1.52	–	4.96
LSD value	1.70	–	–	0.63	0.47	–	1.52

A, B, C, D and F ≡ Cheese sample collected from different area the importance of the packaging in preserving the product. However, we find that it is required and preferred by all consumers.

11.11 Fatty Acids Composition of Collected Cheese Samples

The positive flavor of cheese is the result of the balance between the different flavors compounds produced during re-condensation. Two important classes of compounds that contribute to flavor are volatile sulfur compounds and fatty acids (Weimer et al. 1999). Because milk is not heat treated in the production of traditional white cheese, it is likely that the free fatty acids only contribute to the flavor and aroma of the cheese (Zhao 2009).

11.11.1 Saturated Fatty Acids

Figure 11.9 shows the saturated fatty acid composition of bulk cheese samples in total fatty acid content g/100 g. The fatty acid content differed in all samples, and the most abundant fatty acid samples examined were palmitic acid (C16: 0), stearic acid (C18: 0) and Myristic acid (C14: 0), which ranged from 14.56 to 39.41 and 0.04 to 19.31 and from 0.59 to 1.30 g/100 g respectively, palmitic acid was found to contain the highest level of saturated fatty acid in all cheese samples. Palmitic acid is one of the main saturated fatty acids that raise blood cholesterol, while citric acid does not (Grundy 1997). The level of capric acid and lauric acid for the selected cheese samples was lower than that reported by Kinik et al. (2005) for Turkish white cheese, which reported a range of 2.24–13.11 g/100 g and 7.31–12.00 g/100 g, respectively. On the other hand, the concentrations of long-chain saturated fatty acids (C17:0) and arachidic for the cheese samples were higher than that reported by Kinik et al. (2005), who found a range from 0.45 to 0.71 g/100 g and 0.20–0.27 g/100. In fresh husk cheese, turkey cheese, respectively.

11.11.2 Unsaturated Fatty Acid

There were lower proportions of unsaturated fatty acids compared to saturated fatty acids (Fig. 11.10), with the exception of oleic acid (18:1) which had a high proportion. These results were in agreement with those reported by Sulieman (2001) for the traditional Sudanese milk product “Rob”. Oleic acid was found at a higher concentration (21.95–36.89 g/100 g) in all cheese samples. Results were higher than those reported by Sagdic et al. (2004) and Molkentin (2006) who reported values ranging from (20–24 g/100 g) for Turkish and German dairy products. However, the collected cheese samples contained low values for some unsaturated fatty acids

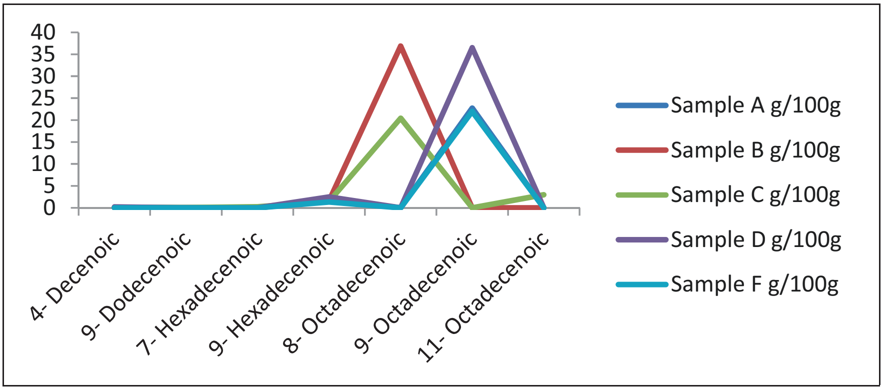

Fig. 11.10 Show Unsaturated fatty acids composition of jibna-beida samples obtained from different area

such as 4-Decenoic acid (10:1), 9-Dodecenoic acid (12:1) and Hexadecenoic (16:1) which ranged from (0–0.10), (0–0.06) and (1.32–2.46) g /100 g, respectively. Organic acids, transporting flavorings to many cheese as a result of the hydrolysis of fatty acids (acetic butter), or natural cows, or biochemistry (Citric, urine) or bacterial growth (lactic, acetic, pyruvic, propionic and formic). These are the main products of the dismantling of carbohydrates from lactic acid bacteria (LAB). The resulting acidity prevents the development of spoilage and pathogenic microorganisms, which improves the healthy quality of cheese (Adde et al. 1982).

11.12 Amino Acids Composition of Collected Cheese Samples

The amount of free amino acids in cheese depends on several factors. These include the quantities of proteins in the raw materials used in production, the activity of proteolytic enzymes in dairy procedures and the microorganisms involved in this process (Yvon and Rijnen 2001). Protein hydrolysis in cheese during ripening plays a vital role in the development of texture as well as flavor and has been the subject of numerous reviews (Fox et al. 1993; Souza et al. 2001; Fox and Ms Sweeney 1998). The determination of free amino acids plays an important role in assessing the nutritional quality of foods (Erbe and Bruckner 2000; Casella and Contursi 2003). In addition, the identification of amino acids also gives an indication of the adulteration and potential transformation that occurs during the processing and storage procedures (Butikofer and Ardo 1999). Figure 11.11 shows the free amino acid content of the pooled cheese samples, expressed as mg of amino acid/100 g sample.

The content of the essential amino acids "threonine, valine, methionine, isoleucine, leucine, phenylalanine and lysine" differed in the different cheese samples. The highest percentage of threonine, lysine was found in cheese samples D (40.41

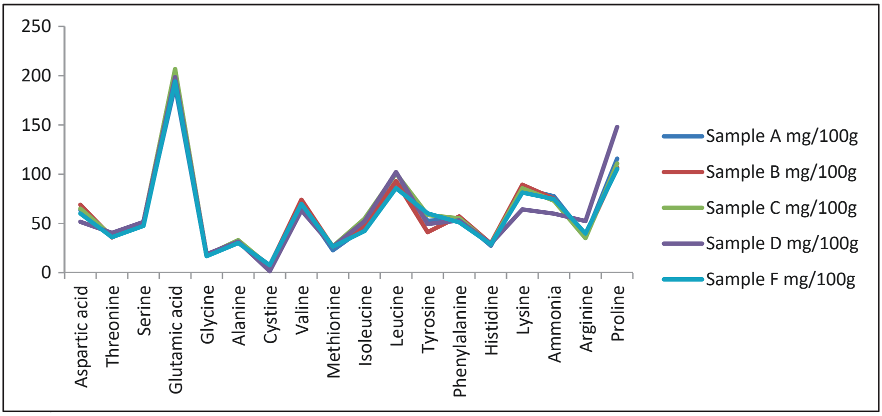

Fig. 11.11 Show Amino acids composition of collected cheese samples

and 102.09) mg/100 g respectively, and the highest percentage of phenylalanine, valine and lysine were found in cheese sample B which were 57.18, 74.07 and 89.38, respectively. The lowest values for threonine (35.78), leucine (85.89), phenylanine (51.13), valine (63.25) and leucine (64.23) were found in the cheese samples (B, F, and D), respectively. The values obtained from essential amino acids in cheese samples were higher than those determined by Ohaj (2009) and Ahmed (2010) in Gouda cheese and white cheese produced in Sudan, where it was found that the content of Thyronine (6.82 and 2.35), Isoleucine (4.79 and 10.48), Phenylalanine (3.73 and 15.84), leucine (8.11and 49.39) and valine (4.62 and 4.76) mg /100 g, respectively.

The content of non essential amino acids "serine, glutamic acid, glysine, alanine, cystine, tyrosine, histidine, NH_4 and arginine" also varied in different cheese samples. The content of non-essential amino acid for collected cheese samples were as follows: serine (51.57), glycine (18.89), arginine (52.29) recorded in sample D, alanine (33.10), glutamic acid (206.77) recorded in sample C, cystine (7.62), tyrosine (60.32) recorded in sample F, histidine (29.52) recorded in sample B. On the other hand, the lowest non-essential amino acids content obtained for collected cheese samples were: glutamic acid, tyrosine, histidine and arginine content were 20.17 mg/100 g, 18.43 mg/100 g, 13.80 mg/100 g and 17.12 mg/100 g, respectively. Also, these values are higher than those reported by Kabelova et al. (2009) who found the content of serine was (9.8 g/kg), glutamic acid (2.3 g/kg), alanine (29.0 g/kg), tyrosine (1.5 g/gk), valine, (7.1 g/kg), henylalnine (9.7 g/kg), and leucine (14.1 g/kg). However, the result have not agreed with those of Sulieman (2001) for Sudanese traditional fermented milk product "Rob" who found that the average content of threonine, valine, methionine, leucine, tyrosine, serine, glutamic acid, histidine and arginine were 1.8 mg/100 g, 1.07 mg/100 g, 0.12 mg/100 g, 2.3 mg/100 g, 4.6 mg/100 g, 2.3 mg/100 g, 3.0 mg/100 g, 0.12 mg/100 g and 0.2 mg/100 g, respectively. Generally the data in Fig. 11.11 show that the collected cheese samples are rich in most of amino acids. These amino acids may be having a role in development of cheese flavour.

11.13 Conclusions and Recommendations

11.13.1 Conclusions

- From the results obtained, it can be concluded that the Sudanese white cheese collected from traditional small factories from several regions has a high nutritional value, as the chemical analysis indicated that most of the chemical components were closely compatible with the literary values with slight differences.
- Microbiological analysis showed the presence of some pathogenic bacteria such as Staphylococcus aureus, Salmonella and Coliform bacteria in some of the cheese samples collected, in addition to the high number of total bacteria, lactic acid bacteria, and the number of yeasts and fungi. This may be due to the use of low-quality milk in the preparation of cheese, or it may be due to unsanitary conditions during cheese processing or to the failure to use heating of milk as a method of preservation.

11.13.2 Recommendations

The following are recommended:

- The use of milk in rural areas to produce Gibna-Bayda under controlled conditions.
- Sanitation, handling of equipment and utensils, application of good manufacturing practices and the production of milk and cheese in good hygienic conditions can increase the shelf life of Gibna-Bayda and make it safer for human consumption.
- Establishing training centers for the production of Gibna-Bayda at the level of small production areas in Sudan by applying health conditions for product safety.
- Educate cheesemakers on good manufacturing practices under good hygienic conditions.
- Future work should include studying Gibna-Bayda production under controlled conditions, using pasteurization of milk and comparing it with conventional production, as well as studying the activities of enzymes to determine their role in cheese production.

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