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Effect of Milk Source and Location on the Physicochemical Characteristics of White Cheese (*Gibna bayda*)

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Authors' contributions

This work was carried out in collaboration between both authors. Author HEAO managed the analyses of the study, managed the literature searches and wrote the first draft of the manuscript. Author MOMA designed the study, wrote the protocol and performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: This study was conducted to evaluate the quality control of white cheese (*Gibna bayda*) processing in traditional plants.
Methodology: White cheese was manufactured using raw cow milk from two areas in North Kordofan (Riash and Cazgail). Samples were collected from three stages (raw milk, curd after pressing and cheese delivered to market). Samples were collected in sterile plastic bags stored at 4°C in ice box and transported to the laboratory of Kordofan University for analysis. Raw milk and cheese were physicochemically (fat, protein, total solids, ash, pH) evaluated during processing stages.
Results: The results showed that all chemical components were not significantly affected by the area in which cheese was made, except fat content which was higher ($P<0.05$) in cheese from Cazgail area (15.68%). During processing stages, fat and protein contents were significantly

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(P<0.001) higher in curd after pressing (16.68% and 14.16% respectively), while the other components (total solids, ash and pH) were not significantly affected by the stage of processing. **Conclusion:** There was no significant variation in physicochemical characteristics of cheese from different areas of milk collection and processing stages, and this indicates that the source of milk is the same for both regions in addition to processing conditions which did not show differences.

Keywords: Gibna bayda; physicochemical; raw milk; traditional plants.

1. INTRODUCTION

Cheese is defined as the solid and compact food made from the milk of cows, goat, sheep and other mammals, having a longer shelf life than the milk from which it is made [1]. Cheese making in Sudan is the major preservation method of the surplus milk in rural areas where plenty of milk is available during the rainy season [2]. Cheese is manufactured throughout the Sudan especially in El Dueim in the White Nile State, El Obeid in North Kordofan State and Nyala in South Darfur State [3]. *Gibna bayda* is the only cheese available in the market to the public in the Sudan [4]. The procedure of manufacturing white cheese in the whole country is similar with slight variations. It starts by collecting the milk from producers or sellers in iron or plastic barrels, followed by salting at the rate of 5-20%; but in winter milk is heated to 38-40°C prior to salting. Rennet tablets (1 tablet/45 L milk) are added to milk after dissolving in tap water. The mixture is left undisturbed for 5–6 h until coagulation occurs, followed by cutting the curd and transferring it to moulds lined with cheese cloth. The curd is pressed overnight to drain whey which is collected for use later in the preservation of cheese. The curd is then removed from the moulds, cut into small cubes and preserved in the whey in covered tins or plastic barrels [4,5].

Method of manufacture and milk composition affect the chemical composition of the produced cheese [6]. *Gibna bayda* contains 47.8% total solids, 14.0% fat, 15.9 % protein and 6.2% ash [7]. The cheese should be stored at suitable temperatures to ensure good quality since high temperature may lead to evaporation of moisture and growth of undesirable microorganisms [7]. Cheese is a complete nutritious food product being an excellent source of nutrients suitable for all ages. *Gibna bayda* is delivered to the market immediately after processing, under inadequate conditions, poor handling technique, inappropriate packaging materials in addition to inadequate storage facilities [1]. The use of milk from different sources beside the traditional method of manufacture may lead to production of cheese with varying chemical composition. Therefore, this study was conducted to determine the physicochemical characteristics of white cheese (*Gibna bayda*) made in traditional cheese plants from milk of different sources.

2. MATERIALS AND METHODS

2.1 Cheese Manufacture

Cheese was manufactured in Riash and Cazgail areas (traditional plants for *Gibna bayda* manufacture) which are located 20 km and 30 km, respectively from El Obeid city, North Kordofan State. Cheese was manufactured as follows: the temperature of milk was recorded (40°C), and then salt was added at the rate of 6-8 kg/50 L milk. Rennet powder (Chr Hansen microbial rennet) was dissolved in 5 ml water and added to milk (1.5 g/50 L milk), stirred for 5 min and left undisturbed to develop a curd. After complete coagulation (3 h), the coagulation time was recorded and the curd was scooped into wooden moulds lined with cheese cloth. The curd was pressed (about 5 kg weight) overnight. Next day the curd was removed from the moulds, and the whey was collected and boiled to remove cheese particles, which were used for the manufacture of *mish*, and the whey left after *mish* manufacture was used for cheese preservation. The cheese was cut into small cubes and immersed into the whey and packaged.

2.2 Sample Collection and Analysis

During manufacture of cheese till delivery to the market, the samples were collected as follows: raw milk; curd before pressing; curd after pressing; cheese delivered to the market. Milk and cheese were collected in sterile plastic bags stored in ice box, transported to the laboratory and stored at 4°C till examination

which was carried out immediately on arrival to the laboratory or within 24 h.

2.3 Determination of Physicochemical Characteristics of Milk

Physicochemical analyses (fat, protein, total solids and density) of milk samples were determined using Lactoscan 90 milk analyzer (Aple Industries Service-La Roche Sur Foron, France).

2.4 Determination of Physicochemical Characteristics of Cheese

The fat content (Gerber method), protein content (Kjeldahal method), total solids content (gravimetric method) and ash content (incineration at 550°C) were determined according to AOAC [8]. The pH was determined using pH meter (Pocket–sized pH meter model H196107, Hanna Instruments, Italy). Before determination, pH meter was calibrated using buffer solutions No. 4 and 7.

2.5 Statistical Analyses

Statistical Analysis Systems (SAS, ver.9) was used for analysis of data. General linear model (GLM) procedure was used to determine the effect of area and processing steps on the physicochemical characteristics of cheese. Duncan multiple range test was used for separation of means ($P \leq 0.05$).

3. RESULTS

The physicochemical characteristics of raw milk used in the manufacture of cheese in Riash and Cazgail areas is presented in Table 1. There was no significant difference ($P>0.05$) in the physicochemical characteristics of milk although fat, protein and TS contents were high in milk used in the manufacture of cheese in Riash area, while pH and ash content were high in milk of Cazgail area. No significant variation ($P>0.05$) was found in all physicochemical characteristics of cheese except fat content. However, total solids, ash and pH were high in cheese from Cazgail area, while the protein and ash contents were high in cheese from Riash area. The fat content was significantly ($P<0.05$) higher in cheese from Cazgail area compared to Riash area (Table 2). Table 3 presents the physicochemical characteristics of curd after pressing and cheese delivered to the market. There was a significant difference ($P<0.001$) in fat and protein contents between curd after pressing and cheese delivered to the market being high in curd after pressing. However, although there was no significant difference ($P>0.05$) between curd after pressing and cheese delivered to the market, TS and ash contents were high (39.53% and 6.22% respectively) in curd after pressing, while pH was high in cheese delivered to the market (Table 3). Only fat and protein contents of curd after pressing from Riash area were significantly ($P<0.05$) higher (15.23 and 15.20%, respectively), while the other physicochemical characteristics were not significantly different ($P>0.05$) between curd after pressing and cheese delivered to the market. Total solids (39.97%) was high in curd after pressing, while ash content (5.77%) and pH (5.13) were high in cheese delivered to the market (Table 4). Similar results were reported in cheese from Cazgail area, with significantly ($P<0.05$) higher fat content (18.13%) in curd after pressing. The other physicochemical characteristics of cheese were not significantly ($P>0.05$) different in curd after pressing and cheese delivered to the market, although higher contents of protein (14.55%), total solids (40.07%), ash (6.38%) and pH (5.76) were found in curd after pressing (Table 5).

4. DISCUSSION

White cheese (*Gibna bayda*) is familiar in Sudan and produced in rural areas under traditional conditions. The cheese is consumed by the majority of Sudanese, and it is manufactured from raw whole cow milk under unhygienic conditions. The milk used for its manufacture in the two areas under study revealed that both milks used in the manufacture might have come from the same source (i.e. same breed). During the pressing of cheese, all chemical components decreased from curd before pressing till delivery to the market in cheese from both areas (Table 3) and cheese from Riash and Cazgail areas (Tables 4 and 5). The variation in the chemical composition of *Gibna bayda* produced in different areas of Sudan might be due to the source of milk and the processing methods applied during the manufacture, and it is clear that the cheese manufactured in all these areas from raw milk of local breed but the breed might differ from area to another. The cheese made in two areas was the same in physicochemical characteristics except fat which was slightly higher ($P<0.05$)

incheese made in Cazgail area, and this might be due to adulteration of milk used for cheesemaking in Riash area or that the milk is from crossbred cows, while milk from Cazgail area comes from local breeds with high fat content. White cheese manufactured in traditional areas had lower composition compared to other cheeses worldwide [9,10,11].

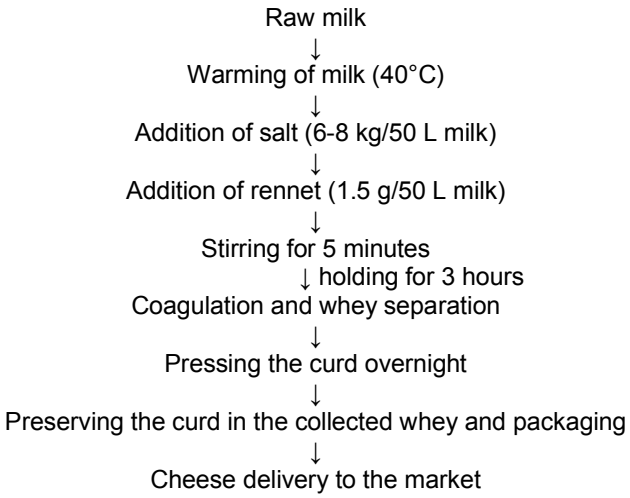

Fig. 1. Flow diagram for the manufacturing steps of *Gibna bayda*

Table 1. Physicochemical characteristics of raw milk used for the manufacture of cheese (mean±SD)

Physicochemical characteristics (%)	Area from which samples were collected		*P*
	Cazgail	Riash	
Fat	4.80±0.742[a]	4.68±0.475[a]	0.9567
Protein	3.39±0.616[a]	3.28±0.095[a]	0.6230
Total solids	8.76±1.610[a]	8.58±0.157[a]	0.7612
Ash	0.637±0.093[a]	0.646±0.071[a]	0.5230
pH	6.70±0.179[a]	6.80±0.089[a]	0.8143

Means in the same row bearing same superscripts are not significantly different (p>0.05)
SD = Standard deviation

Table 2. Physicochemical characteristics of white soft cheese (*Gibna bayda*) delivered to the market from two areas under study

Physicochemical characteristics (%)	Area in which cheese was manufactured		SE	*P*
	Riash	Cazgail		
Fat	12.27[b]	15.68[a]	0.859	0.0300
Protein	14.26[a]	14.16[a]	0.185	0.9321
Total solids	38.74[a]	39.54[a]	0.277	0.1190
Ash	5.60[a]	5.88[a]	0.551	0.2090
pH	5.47[a]	5.61[a]	0.137	0.2678

Means in the same row bearing same superscripts are not significantly different (p>0.05).
SE = Stander error of means

Table 3. Physicochemical characteristics of curd after pressing and cheese delivered to the market (average from two areas)

Physicochemical characteristics (%)	Curd after pressing	Cheese delivered to market	SE	*P*
Fat	16.68[a]	11.27[b]	0.859	<0.0001
Protein	14.16[a]	13.54[b]	0.185	0.0002
Total solids	39.53[a]	38.76[a]	0.551	0.1920
Ash	6.22[a]	5.27[b]	0.277	0.3209
pH	5.46[a]	5.61[a]	0.137	0.9012

Means in the same row bearing same superscripts are not significantly different (p>0.05).
SE = Standard error of means

Table 4. Physicochemical characteristics of curd after pressing and cheese delivered to the market from Riash area

Physicochemical characteristics (%)	Curd after pressing	Cheese delivered to market	SE	*P*
Fat	15.23[a]	9.31[b]	1.086	0.0340
Protein	15.20[a]	13.20[b]	0.312	0.0229
Total solids	39.97[a]	38.49[a]	0.748	02310
Ash	5.17[a]	5.77[a]	0.295	0.8832
pH	4.07[a]	5.13[a]	0.056	0.5598

Means in the same row bearing same superscripts are not significantly different (p>0.05)
SE = Standard error of means

Table 5. Physicochemical characteristics of curd after pressing and cheese delivered to the market from Cazgail area

Physicochemical characteristics (%)	Curd after pressing	Cheese delivered to market	SE	*P*
Fat	18.13[a]	13.23[b]	0.659	0.0257
Protein	14.55[a]	13.77[a]	0.109	0.9015
Total solids	40.07[a]	39.02[a]	0.798	0.8934
Ash	6.38[a]	5.40[a]	0.411	0.6025
pH	5.76[a]	5.46[a]	0.231	0.7739

Means in the same row bearing same superscripts are not significantly different (p>0.05)
SE = Standard error of means

The decrease in fat content is in agreement with the findings of Abdalla et al. [12]. The result of decrease in protein is in disagreement with Abdalla et al. [13]. Salih et al. [4] reported that the average chemical composition of white cheese (Jibna-beida) collected from different areas in Sudan is as follows: fat 22.27±3.04, protein 20.12±1.14, total solids 50.13±5.24, ash 5.57±0.64, pH 4.85±0.54. Protein, total solids and ash contents of white soft cheese were significantly higher in cheese made from raw milk compared to cheese made from heat treated milk (63°C/30 min and 72°C/1 sec), except for fat content which was not significantly affected by the heat treatment of milk [14]. The results of total solids and ash contents are in line with the findings of Sert et al. [15] and Abdalla et al. [13]. The pH of cheese decreased in the period from pressing to delivery to the market, and this could be due to lactose breakdown into lactic acid bacteria leading to formation of lactic acid. The

results are in accord with Abdalla et al. [12], Cetinkaya and Soyutemiz [16], Sert et al. [15] and Abdalla et al. [13]. The pH of curd after pressing in Riash area is lower than that reported by Abdalla and Abdel Razig [17] for cheese manufactured from cow, goat or mixed milks. The average chemical composition of *Gibna bayda* from Zalingei area, West Darfur.State, Sudan was as follows: fat 22.8%, protein 22.50%, total solids 52.77%, ash 4.87% and titratable acidity 1.87% [18]. However, Hamid and ElOwni [19] reported an average fat, protein, total solids and ash contents of cheese samples collected from South and West Darfur states, Sudan to be 23.79%, 20.4%, 52.8%, 5.34% and 1.035, respectively. The results in this study are in disagreement with the findings of Vasek et al. [20] who reported higher fat, protein, total solids contents and pH of Argentinean Corrientes cheese. Similar results were reported by Gonzalez-Vinas [21] for pH of Manchego cheese of Spain. However, Ballesteros et al. [22] reported higher values of TS content of artisanal Manchego cheese of Spain.

5. CONCLUSION

This research indicated that physicochemical characteristics of cheese from two areas are similar. However, it is needed that the methods of processing cheese should be improved in order to produce a product that complies with the standards set by the legislative authorities. This research is an attempt to find out how this product is traditionally produced and to compare this method with the methods used in research laboratories in the country in order to convince the producers in remotes areas to adopt the improved methods for cheese production for the benefit of the consumer.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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