applied sciences

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Nutritional and Food Safety Characteristics of Jameed—A Traditional Dairy Product of Drylands

Muhi El-Dine Hilali [1,*], Mourad Rekik [2], Jomana Hijazi [3] and Hotheifa Ababenah [3]

1 International Center for Agricultural Research in the Dry Areas, Amman 11195, Jordan
2 International Center for Agricultural Research in the Dry Areas, Tunis 2049, Tunisia
3 National Agricultural Research Center, Baqa 19381, Jordan
* Correspondence: m.hilali@cgiar.org; Tel.: +962-786-304-064

Abstract: Jameed is a traditional dried dairy product in Jordan that is known under different names in the Middle East, Turkey, Central Asia, China, and Mongolia. It has been produced in the region for centuries and makes a significant contribution (up to 20%) to the income of small-scale traditional dairy processors who are based in sheep-producing districts. This study aims to assess the nutritional value of Jameed as a model for traditional dried fermented dairy products and to highlight the safety of the product quality and some of the health risks that may arise. For this purpose, 80 samples of Jameed were collected from the market covering all regions of the Kingdom of Jordan. The samples were analyzed for nutritional value and health risks by standard and approved methods. Results show that the total solids were 84.57%, with a large variation from 73 to 92%. Producers use a lot of salt to control elevated acidity during the drying of Jameed. The salt concentrations in collected samples were 15.68%. The average acidity was 6.79%. Moreover, farmers heavily use antibiotics to control mastitis without observing milk withdrawal. The residues of antibiotics were detected in 50.65% of the analyzed samples. The samples show large variations in measured values, reflecting differences in processing methods, homogeneity, and standardization.

Keywords: Jameed; fermented milk; dried dairy product; small ruminates milk; dryland

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Citation: Hilali, M.E.-D.; Rekik, M.; Hijazi, J.; Ababenah, H. Nutritional and Food Safety Characteristics of Jameed—A Traditional Dairy Product of Drylands. *Appl. Sci.* **2024**, *14*, 678. https://doi.org/10.3390/app14020678

Academic Editor: Pawel Glibowski

Received: 15 November 2023
Revised: 25 December 2023
Accepted: 27 December 2023
Published: 13 January 2024

1. Introduction

Fermented milk products, which are derived from various sources such as cow, sheep, goat, water buffalo, and camel, have a long history of production in the Middle East, Central Asia, and the Caucasus, dating back to before the Phoenician era, and continue to be produced today [1]. Focusing on the Middle East as an example, livestock, particularly sheep production, is a mainstay of Jordan's rural communities, particularly in Karak, which is famed nationwide for its cheese, yogurt, and Jameed—a 'rock cheese' that forms the basis of the country's national dish, Mansaf. In this region, some 330,000 heads of sheep produce approximately 8500 tons of milk that are processed during the milking season from January till June. Jameed is a fermented dairy product made by concentrating and drying skimmed fermented milk and yogurt obtained from sheep or/and goats [2–4]. The making of this dried dairy product has a long tradition, forming an essential part of Jordan's cuisine and culture. This traditional dairy product is well known in many dryland regions like Central Asia, the Caucasus, and Mongolia. However, the chemical composition of traditional dairy products varies significantly between places, provinces, and farmhouses owing to variations in the biological content of milk throughout the lactation period and to processing practices [5]. The main advantages of producing dried fermented dairy products (Jameed) are the long shelf life of the product, the reduction in the bulk to save storage space, and a reduction in packaging and transportation costs. The product is reconstituted by soaking and dissolving in water after crushing or grinding and is consumed as a yogurt drink after boiling or in the form of a hot soup when cooked with meat [6].

Buttermilk is obtained by churning fermented milk and yogurt. Buttermilk is strained using a cheesecloth until all the whey drains off, leaving a thick white paste in the cloth. The dense paste is then salted and shaped into round balls before being allowed to dry for several weeks until it reaches a stone-hard consistency [7]. Jameed is characterized by a unique salty and sour flavor with a lingering aftertaste, while the color may be yellowish or white, depending on whether it has been dried in the sun or in the shade. It is important that Jameed is dry to the core because any dampness can spoil the preservation process.

Jameed is produced in different shapes and forms that, in turn, affect the amount of final moisture in the product and also the amount of time needed to reach its final dryness [6]. Traditionally, Jameed is manufactured in the shape of an elongated ball [6] and can be classified as a shelf-stable product produced by fermenting and drying milk. It is shelf-stable because it has a combination of low moisture and pH, high salt content, and contains lactic acid bacteria that decrease the growth of pathogenic microorganisms [8]. Jameed can be kept for years at an ambient temperature without spoiling and losing its nutritional value. Jameed has excellent nutritional value due to its high protein and fat content. It is a significant item of the nutritional well-being of the local populations during periods of the year when fresh milk is not available [9]. Moreover, dried fermented dairy products, including Jameed, are stored under room temperature conditions till marketing, which makes them ideal for processing milk in remote areas and nomadic communities [10]. Nutrition experts have acknowledged the potential health benefits of fermented milk, which have been observed to be superior to those of liquid milk [1].

In an attempt to contribute to the characterization of dried fermented dairy products, this study aims to assess the nutritional value and potential human health risks of the typical Jordanian Jameed, bearing in mind that similar products are encountered in the dry regions across the Middle East, Mongolia, Central Asia, the Caucasus, and China.

2. Materials and Methods

2.1. Sampling

Samples of Jameed were collected from the local Jordanian market. In total, 80 samples were collected from the districts of Ajloun, Elkarak, Elshobak, Irbed, Jarash, Mafraq, Tafila, and Zarqa. There is a huge variability among districts in terms of climate, agroecology, and the biophysical context, which may affect the production system, milk quality, and the quality of the processed final product (Table 1). Each sample consisted of 2–3 balls of Jameed. Then, in the laboratory, each ball was weighed, broken, and ground into a powder form using a mill (Thomas Wiley Mill Model 4, Swedesboro, NJ, USA) equipped with a 1 × 1 mm sieve and stored refrigerated in zipped bags for later analysis.

Table 1. Climate, agroecology, and the biophysical information of the sampling districts.

Districts	Type of Climate	Area	Temperature		Average Annual Rainfall	Altitude
		km^2	Min °C	Max °C	mm	m
Ajloun	Mediterranean climate	420	3	36	611	719
Elkarak	Desert climate	3495	19.18	29.23		973
Elshobak	Cold desert climate	32,832	13.72	24.14	41.4	1120.61
Irbed	Hot-summer Mediterranean climate	1572	5	31	449.2	620
Jarash	Mediterranean climate	410	5	33	339.9	520–750
Mafraq	Cold semi-arid climate	26,551	3	36	149	915
Tafila	Mid-latitude steppe climate	2209	2	31	191.5	970
Zarqa	Cold semi-arid climate	4761	3	37	125.2	570–660

Source: Ministry of Agriculture and National Agricultural Research Center.

2.2. Chemical Analysis

Total solids (TS) were determined using the standard method of drying the samples at 105 °C overnight using an air-forced oven [11]. Fat content was determined according to van Gulik method [12], and protein was determined using the Kjeldahl method [13]. Ash was determined according to the AOAC official method 991.25 [13].

Titratable acidity was determined by mixing 1 g of Jameed with 99 mL of distilled water and titrating this solution with 0.1 N NaOH in the presence of a phenolphthalein indicator until the solution turned to a pallid pink color. For each sample, measurements were carried out in triplicate. Results were expressed as percent of lactic acid in the product.

2.3. Mineral Determination

Minerals were determined according to AOAC Official Method 991.25 [13]. Total calcium (Ca) and magnesium (Mg) were determined using atomic absorption spectrometry system (ContrAA 800, Analytikjena, Überlingen, Germany); phosphorus (P) was analyzed using a double-beam spectrophotometer (UV-2600, Shimazu, Tokyo, Japan), whereas sodium (Na) and potassium (K) were analyzed using a flame spectrophotometer (Flame Photometer 410, Sherwood Scientific Ltd., Cambridge, UK). The salt content was calculated from Na content.

2.4. Color Measurements

Color measurements of all Jameed samples were performed using a portable colorimeter equipped with a 12 mm/45 conical sensor. Measurements were performed with reference to illumination D65 (standard daylight, according to the Commission Internationale de l'éclairage—CIE) and at angular subtense from 10° for vision at the photopic level [14].

The color of Jameed balls was measured by reading the color of three spots of a Jameed ball, and three balls were measured per sample.

The powdered Jameed samples were put in a special black no-reflective Teflon measuring cylinder (Ø60 mm × 23 mm), and the surface was flattened by the press cover of the cylinder to a marked level before measuring color. The measuring sensor was mounted directly on top of the measuring cylinder to prevent ambient light noise. Three replicates per sample were obtained. Results were expressed in CIE Lab color parameters: L* (lightness value, 0 black to 100 White); a* (−green to +red); and b* (−blue to +yellow) [14,15]. Additionally, the color difference (Δe) was calculated using $\Delta e = \sqrt{L^{*2} + a^{*2} + b^{*2}}$ [16], and gloss was presented.

2.5. Antibiotic Residues and Microbial Investigation

Antibiotic residues in the collected Jameed samples were assessed using a high-sensitivity wide-range antibiotic detection test kit for milk and dairy products (MaxSignal® Total Antibiotics in Milk, (1023-2), Bio Scientific, Austin, TX, USA). The kit uses the microbial inhibition test method. Detection means that concentrations in samples exceed the maximum residue limits (MRL) allowed. Other potential health threats related to zoonotic diseases that can be transmitted by sheep were investigated in Jameed samples. These are brucellosis, chlamydiosis, and Q fever. For this purpose, the following commercial ELISA kits were used: the Brucellosis Serum X2 Ab Test kit (IDEXX, Westbrook, ME, USA) for Brucella; the Chlamydiosis Total Ab Test kit (IDEXX, Westbrook, ME, USA) for Chlamydia; and the Q Fever Ab Test kit (IDEXX, Westbrook, ME, USA) for Q fever. Jameed samples were diluted in the given kit sample solvent and followed the procedure provided by the manufacturer. All used kits contained a negative and a positive control to compare readings.

2.6. Statistical Analysis

Statistical analyses were conducted using SAS software v. 9.2 (SAS Institute Inc., Cary, NC, USA). The possible differences among the samples were analyzed using linear models following the SAS, Proc GLM procedure, considering the region of sampling as a fixed effect and the analyzed traits as a dependent variable, whereas the detection of harmful bacteria and the antibiotic residue frequencies were analyzed using the SAS, Proc Freq procedure. Possible correlations of variables were assessed using SAS, Proc CORR procedure.

3. Results

The weight of Jameed balls differed among regions. In general, Jameed is processed in big balls in the southern part of the country, e.g., Tafila and El-Karak regions. However, some producers in Irbed, northern Jordan, also produce Jameed in big balls that can reach up to 700 g (Figure 1). However, some producers produce Jameed in small balls that have a weight of around 50 g, like in Ajloun. Moreover, within regions, there are large variations in ball size (Figure 1).

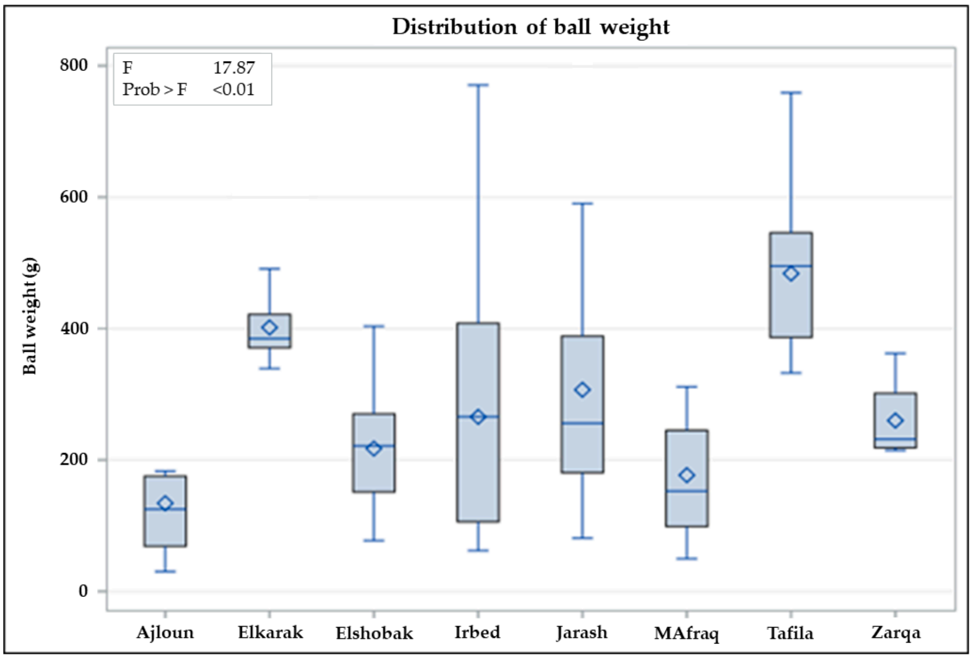

Figure 1. Jameed ball weight (g) by region. Symbol in the box interior represents the group mean;, horizontal line in the box interior represents the group median; whiskers extend to the group minimum and maximum values.

Main Chemical Composition

Jameed's total solids significantly differed among regions ($p < 0.01$, Table 2). The TS of Jameed obtained from Tafila was 15.2% lower compared to the TS average, whereas the TS obtained from Ajloun and Zarqa was 5.1 to 6.9% higher. This seems to be correlated with the use of salt as it increases the osmosis (r = −0.58, $p < 0.01$).

Jameed protein makes up, on average, 56% of the TS. Similar to the TS content, the protein content differed significantly among regions ($p < 0.01$) from 36.9% in Tafila up to 54.4% in Zarqa, with an average of 47.2% (Table 2). This is affected very much by processing practices and the proportion of sheep and goat milk in the bulk milk used for processing, as well as the concentration of salt used.

Table 2. Chemical characteristics of Jameed.

Region	TS %	Protein %	Fat %	Acidity %
Ajloun	90.67 ± 1.8 [c]	51.56 ± 1.53 [c]	17.62 ± 1.43 [e]	7.12 ± 0.27 [cd]
Elkarak	83.46 ± 1.21 [b]	45.36 ± 1.16 [b]	8.86 ± 1.36 [a]	5.4 ± 0.21 [a]
Elshobak	82.69 ± 1.35 [b]	47.08 ± 1.24 [b]	11.18 ± 1.5 [abc]	6.45 ± 0.23 [bc]
Irbed	83.96 ± 1.2 [b]	48.54 ± 1.11 [b]	15.58 ± 1.65 [cde]	7.33 ± 0.2 [d]
Jarash	84.92 ± 1.17 [b]	45.62 ± 1.05 [b]	10.37 ± 1.39 [b]	7.47 ± 0.19 [d]
Mafraq	85.59 ± 1.83 [b]	48.26 ± 1.57 [b]	14.74 ± 2.26 [bcde]	7.17 ± 0.31 [cd]
Tafila	73.1 ± 1.33 [a]	36.9 ± 1.22 [a]	16.98 ± 1.5 [de]	6.12 ± 0.22 [b]
Zarqa	92.16 ± 2.69 [c]	54.43 ± 2.36 [c]	11.6 ± 2.6 [bcd]	7.27 ± 0.41 [cd]
p-value	<0.01	<0.01	<0.01	<0.01

[a–e] Values with different superscripts within column differ ($p < 0.05$).

There were large variations of the fat content in the studied samples between regions ($p < 0.01$). Variations were also depicted between samples within the region. In general, the variations were from 2 to 33%. Fat content that was related to processing practices and churning efficiency was lower in Jameed produced in Elkarak ($p < 0.01$), well known for producing the best Jameed (Table 2), whereas the content was 31.8% higher in samples collected in Ajloun.

The acidity of Jameed, which is very much affected by the environmental temperature and traditional flora of yogurt used as an inoculant, varies among the regions ($p < 0.01$, Table 2); the values obtained from the samples were from 3.3 to 9.7%. Jameed collected from Elkarak region had 20.5% less acidity, whereas samples from Jarash had 10% higher than average acidity.

Ash content in Jameed samples did not differ among regions ($p > 0.05$, Table 3), whereas the minerals and salt content showed significant differences among regions ($p < 0.01$, Table 3), and the highest salt content was found in the middle regions of Jordan, Tafial, Elshobak, and Elkarak.

Table 3. Mineral and salt content of Jameed.

Region	Ash %	Mg mg/100 g	Ca mg/100 g	P mg/100 g	K mg/100 g	Na g/100 g	Salt g/100 g
Ajloun	15.04 ± 0.62	71.78 ± 3.04 [bc]	304.18 ± 14.4 [a]	618.57 ± 22.84 [a]	253.56 ± 14.92 [cd]	5.51 ± 0.23 [a]	14.01 ± 0.63 [a]
Elkarak	17.18 ± 0.54	65.73 ± 2.53 [b]	383.63 ± 12.02 [c]	722.16 ± 19.07 [c]	183.51 ± 12.46 [a]	6.73 ± 0.19 [cde]	17.11 ± 0.52 [cd]
Elshobak	16.58 ± 0.58	55.42 ± 2.8 [a]	351.66 ± 13.29 [bc]	689.89 ± 21.08 [bc]	223.17 ± 13.77 [bc]	6.32 ± 0.21 [bd]	16.11 ± 0.54 [bc]
Irbed	15.91 ± 0.5	77.4 ± 2.43 [cd]	367.28 ± 11.51 [c]	691.52 ± 18.26 [bc]	221.98 ± 11.93 [bc]	5.95 ± 0.18 [abc]	15.14 ± 0.47 [abc]
Jarash	15.58 ± 0.49	65.07 ± 2.36 [b]	332.39 ± 11.2 [ab]	649.51 ± 17.77 [ab]	215.02 ± 11.61 [ab]	5.83 ± 0.18 [ab]	14.84 ± 0.46 [ab]
Mafraq	15.43 ± 0.71	92.24 ± 3.43 [e]	352.47 ± 16.27 [bc]	722.11 ± 25.82 [c]	291.29 ± 16.87 [d]	5.79 ± 0.26 [ab]	14.74 ± 0.66 [ab]
Tafila	18.59 ± 0.55	83.61 ± 2.66 [d]	431.4 ± 12.6 [d]	675.12 ± 20 [abc]	231.1 ± 13.07 [bc]	7.22 ± 0.2 [e]	18.4 ± 0.51 [d]
Zarqa	16.99 ± 1.06	67.78 ± 5.15 [bc]	480.37 ± 24.41 [d]	820.45 ± 38.73 [d]	231.08 ± 25.3 [abc]	5.92 ± 0.39 [abe]	15.07 ± 1 [abc]
p-value	0.084	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

[a–e] Values with different superscripts within column differ ($p < 0.05$).

Jameed's color is an essential criterion for consumers and affects Jameed's marketing and price. Both lightness and decrease in redness and yellowness are particular key factors for consumer acceptance. The color of the Jameed surface, which attracts the consumers, as well as the color of powdered Jameed, differed from one region to another ($p < 0.01$, Tables 4 and 5). In general, the powdered Jameed reflecting the core color was, on average, 5% lighter than the surface color of the samples in Tables 4 and 5. The color difference was affected mainly by the lightness (L*) or whiteness of the product (Tables 4 and 5).

Table 4. Surface color of Jameed.

Region	Color Parameters [1]			Color Difference	Gloss
	L*	a*	b*		
Ajlun	87.17 ± 0.66 [c]	1.23 ± 0.50 [a]	15.67 ± 0.49 [cd]	88.69 ± 0.55 [cd]	1.42 ± 0.04 [b]
Elkarak	86.02 ± 0.65 [c]	2.47 ± 0.20 [b]	15.05 ± 0.48 [bc]	87.43 ± 0.54 [c]	1.48 ± 0.03 [bc]
Eshobak	87.17 ± 0.56 [c]	2.12 ± 0.20 [ab]	15.83 ± 0.41 [cd]	88.74 ± 0.46 [cd]	1.46 ± 0.03 [b]
Irbed	83.59 ± 0.53 [b]	2.41 ± 0.17 [b]	17.96 ± 0.39 [e]	85.88 ± 0.44 [b]	1.43 ± 0.03 [b]
Jarash	88.66 ± 0.59 [c]	3.26 ± 0.16 [c]	15.32 ± 0.43 [bc]	90.07 ± 0.49 [d]	1.56 ± 0.03 [c]
Mafraq	81.62 ± 0.78 [a]	1.59 ± 0.18 [a]	17.06 ± 0.58 [de]	83.64 ± 0.65 [a]	1.26 ± 0.04 [a]
Tafila	88.04 ± 0.63 [c]	1.63 ± 0.34 [a]	14.07 ± 0.47 [ab]	89.21 ± 0.52 [d]	1.84 ± 0.03 [d]
Zarqa	93.49 ± 1.63 [d]	1.45 ± 0.19 [a]	12.27 ± 1.20 [a]	94.30 ± 1.35 [e]	1.62 ± 0.09 [c]
p-value	<0.01	<0.01	<0.01	<0.01	<0.01

[a–e] Values with different superscripts within column differ ($p < 0.05$). [1] L* = lightness; a* = redness; b* = yellowness.

Table 5. Color of powdered Jameed.

Region	Color Parameters [1]			Color Difference
	L*	a*	b*	
Ajlun	91.97 ± 0.4 [bc]	1.74 ± 0.15 [d]	13.64 ± 0.44 [a]	93.06 ± 0.33 [bcd]
Elkarak	92.31 ± 0.34 [cd]	1.6 ± 0.12 [bc]	12.04 ± 0.37 [a]	93.12 ± 0.28 [cd]
Eshobak	93.16 ± 0.36 [d]	1.15 ± 0.13 [a]	12.01 ± 0.39 [a]	93.97 ± 0.29 [e]
Irbed	91.20 ± 0.32 [b]	1.88 ± 0.12 [cd]	13.77 ± 0.36 [abc]	92.31 ± 0.27 [b]
Jarash	91.90 ± 0.31 [bc]	1.43 ± 0.11 [abc]	14.57 ± 0.34 [abc]	93.10 ± 0.26 [cd]
Mafraq	89.64 ± 0.4 [a]	2.22 ± 0.15 [d]	15.28 ± 0.44 [bc]	90.99 ± 0.33 [a]
Tafila	92.16 ± 0.35 [c]	1.29 ± 0.13 [abc]	11.81 ± 0.39 [cd]	92.93 ± 0.29 [bcd]
Zarqa	93.00 ± 0.65 [cd]	1.42 ± 0.24 [abc]	13.09 ± 0.72 [d]	93.93 ± 0.54 [de]
p-value	<0.01	<0.01	<0.01	<0.01

[a–e] Values with different superscripts within column differ ($p < 0.05$). [1] L* = lightness; a* = redness; b* = yellowness.

The prevalence of antibiotic residues was 53% across all regions, reflecting a high use of antibiotics in sheep. The residues were detected in all samples except those from Zarqa (Table 6). In all analyzed Jameed samples from all the districts, there was no presence of *Brucella*, *Chlamydia*, or Q fever.

Table 6. Cases of antibiotic residues detected in collected samples (%).

	Ajloun	Elkarak	Elshobak	Irbed	Jarash	Mafraq	Tafila	Zarqa	Total
Negative	6.94	9.72	4.17	3.48	8.33	1.39	9.02	4.17	47.22
Positive	4.17	4.87	9.72	13.89	8.33	6.94	4.87	0	52.78
Total	11.11	14.59	13.89	17.37	16.66	8.33	13.89	4.17	100.00

4. Discussion

Based on observations, producers in Ajloun process Jameed from lightly concentrated buttermilk and produce Jameed with small spherical shapes to increase the drying surface, which becomes flattened later and could be responsible for the lighter weight in comparison to other regions. Producers in some regions, such as Elkarak and Zarqa, produce Jameed balls from well-concentrated buttermilk, which are more homogeneous in shape and weight because it is desirable for consumers. In other regions, such as Irbed and Jarash, Jameed is produced in different shapes, and weights can range from 50 to 800 g. This is related to consumer preferences as well as to producer skills. The Jameed produced in Elkarak is used as the reference as it is very well known all over the country.

4.1. Main Composition

Jameed from the Tafila region, characterized by highlands with cold weather that affects the drying process of Jameed, had 15% less TS than other regions. However, all samples, except those from Tafila, complied with the Jordanian standards and regulations for Jameed processing, requiring that the moisture content in the final product should not exceed 20%. Moreover, our results agree with those of other studies that reported a range in TS of Jameed of 85–95% [17–20]. This is a very important criterion because humidity exceeding 20% will reduce quality and shelf life and increase the risk of mold growth in Jameed.

Although reported average protein content values in this study agree with earlier findings [20–23], our hypothesis to explain the large differences in protein and, consequently, TS contents lies within the adoption of different thermal treatment intensities and processing methods in the regions. Thermal treatment of milk can capture some whey proteins due to a certain denaturation and results in reduced protein losses during processing. In the traditional processing method, buttermilk (which is diluted with at least 30% water for churning) is concentrated by heating to a maximum of 55 °C and followed by the concentration process in a cotton bag in which the whey is separated out [22]. During the first few hours of whey syneresis, fine casein particles can be carried out with the whey, making the whey white to slightly white, and some producers apply pressure to speed up this process [24].

Jameed samples from Elkarak had the lowest fat content, which could be due to higher efficiency in fat separation. In general, fat separation is based on the churning of diluted fermented milk. The churning is carried out by centrifugation of the diluted fermented milk, which in many cases has not sufficiently coagulated due to low acidification, particularly in cold weather [25]. Consumers in the Elkarak region prefer acidic, strong-flavored yogurt and Jameed. Therefore, churning efficiency is higher in this region due to the process of elevated yogurt acidity that neutralizes the fat globule electrical charge and enhances the separation [26–28]. Fat values reported in Jordan were 8–13% [19–21] compared to fat values for Syrian Jameed of approximately 5.5% [3]. In fact, fat can affect the quality of Jameed negatively because of fat rancidity during long storage in room temperature conditions [29]. Therefore, low-fat content is considered a quality indicator for a good product.

Globally, the acidity of Jameed was in agreement with values reported by other researchers [9,20,22]. The low acidity in Jameed samples from Elkarak could be due to the elevated acidity produced during the fermentation before the churning process, which is washed out through the syneresis process later [28]. Low acidification during the fermentation process will leave lactose in the product that will later ferment slowly into lactic acid during the concentration process and will be accumulated and further concentrated in the drying process, which could be the case of the Jameed with high acidity [26,28].

4.2. Minerals

The ash content represents the total minerals in Jameed. The obtained values did not differ from those reported in other studies [3,17–19]. The difference in Ca content could be affected by the processing method because Ca can be drained and lost with the whey during the drying process of Jameed with elevated acidity. The lowest Ca content was observed in Ajloun because farmers in this region mix sheep milk with goat milk, which is less concentrated in Ca than sheep milk [3,30]. The low values obtained in Eshobak and Mafraq are due to the processing of yogurt that is acidic, as preferred by the consumers, which facilitates the movement of Ca to the liquid phase of the gel and is lost with the whey during the concentration process [26]. Samples collected from Tafila and Mafraq were high in Mg (important for skeletal muscles and bone health) [3,30–32]. The low values obtained in El Eshobak and Mafraq are due to the processing of yogurt that is acidic, as preferred by consumers, which facilitates the movement of Ca to the liquid phase of the gel and is lost with the whey during the concentration process [26]. In samples collected from Tafila and Mafraq, Mg (important for skeletal muscles and bone health) [31,32] was the highest, with 16% and 27% higher values than the average of collected samples, respectively. The P content in Jameed produced in Ajloun was the lowest of all regions, possibly due to mixing sheep milk with goat milk, which contains fewer minerals than sheep milk (Table 3). Both P and K values obtained in this study were in the range reported in the region for other similar types of dairy products [3].

All samples had salt concentrations above the 12% prescribed in the Jordanian standards and regulations, which is confirmed in previous findings to be higher than 10% [3,20,23]. The average salt concentration in the current study was 15.68%, with regions in northern Jordan like Mafraq, Jarash, and Ajloun using less salt compared to regions in the south. Such a practice of adding more salt in the southern parts is an attempt by the processors to control product cracking due to CO_2 production in hot regions by inhibiting bacterial activity during the drying process [25], but the high salt concentrations can also inhibit yeasts during the drying process.

4.3. Jameed Color

The preferred color for Jameed by consumers is white, creamy, and a light–bright color [21,33]. It seems that churning efficiency plays an essential role in the end product's color. Fat residues can enhance an unwanted yellowish color, which was greater when the b* color value was higher ($p < 0.01$, Table 4). This effect also goes deep to the core of Jameed balls (Table 5). Furthermore, a prolonged drying process, which often occurs in traditional Jameed processing, supports the growth of some wild yeasts on the surface, which also causes a yellowish color on the Jameed ball surface. Moreover, added salt in the preparation of Jameed may support the color lightness as it inhibits the growth of hydrolytic microorganisms and thereby enhances the lightness of Jameed, as noted by the relatively greater lightness and lower yellowness and redness values [21].

4.4. Antibiotic Residues and Microbiological Quality

The risk of consuming products contaminated with antibiotic residues leading to the eventual failure of antibiotic therapy is well known. Moreover, long-duration exposure might alter the nature of human gut microflora, resulting in the enhancement of many diseases. Jameed is usually diluted two–three times before consumption, which would lower the estimated daily intakes, which thereby may become lower than the acceptable daily intakes [34]. The high prevalence of antibiotic residues in dairy products has been cited in other regions like Brazil [35]. The undetectable levels of antibiotic residues in the Zarqa district are difficult to explain, and such a finding deserves further investigation.

The reason for not detecting *Brucella*, *Chlamydia*, or Q fever could be due to the low prevalence of these germs in the sheep flocks from which the milk was used to produce the Jameed. It may also be combined with the effect of the high salt concentration and low pH during the first stage of processing, which seems to help in controlling the germs causing these zoonotic diseases and contribute to providing safe products [36]. Moreover, a value of 5.4% for acidity reported in Elkarak can still inhibit coliform during storage [9].

5. Conclusions

Jameed is a nutritious food with a high content of high-quality protein and is very rich in minerals, particularly Ca and P. However, the high salt concentration exceeding the levels of standards and regulations could be a risk for persons with heart health and blood-pressure problems. Moreover, the mixing of sheep and goat milk will contribute to the product characteristics. The traditional method of shaping the balls by hand makes it very difficult to maintain consistency in weight per ball. In some traditional processes, Jameed with a high fat content shows heterogeneity in fat content clearly due to low churning efficiency during the processing steps. We recommend introducing simple modifications to Jameed processing methods like pasteurization to control zoonotic diseases and microbial quality. Also, it is preferable to lower the salt concentration, enhance fat separation, and produce a more homogeneous product through processing modifications to supply high-quality products meeting the Codex Alimentarius standards and regulations.

Author Contributions: Conceptualization, M.E.-D.H. and M.R.; methodology, M.E.-D.H.; sampling, J.H. and H.A.; formal analysis, M.E.-D.H., J.H. and H.A.; data curation, M.E.-D.H.; writing—original draft preparation, M.E.-D.H.; writing—review and editing, M.E.-D.H., M.R., J.H. and H.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the International Fund for Agricultural Development (IFAD Grant 1240-ICARDA), and by the Arab Fund for Economic and Social Development (ICARDA No 200155).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available as it is a part of a bigger study which is still under publication.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of this study, in the collection, analyses, or interpretation of the data, in the writing of this manuscript, or in the decision to publish the results.

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