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EFFECT OF JAMEED FORM ON THE CHEMICAL COMPOSITION, RHEOLOGICAL AND MICROBIAL PROPERTIES

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ABSTRACT

Nine treatments to study the effect of jameed form (triangle, square and cylinder molds) on the chemical composition, rheological and microbial properties. The treatments were made as follow: (A) sheep buttermilk (control) with ball form, (B) goat skim milk with ball form, (C) goat skim milk with triangle form, (D) goat skim milk with square form, (E) goat skim milk with cylinder form, (F) cow skim milk with ball form, (G) cow skim milk with triangle form, (H) cow skim milk with square and (I) cow skim milk with cylinder form. Yield of cylindrical shape were slightly higher, while levels of ball, triangle and square forms were close to each other. The lowest acidity levels were detected in cylindrical form. Square and cylinder forms were recorded the lowest of TS, fat, total protein and ash values. Square and cylinder forms possessed the lowest TVBC, LAB and proteolytic bacteria. The triangle or square molds caused significant ($p<0.05$) increase in wettability, where square form scored the highest syneresis levels among different shapes. The spherical and cylindrical shapes had the minimum values of hardness, cohesiveness, gumminess and chewiness whereas the triangle and square forms possessed the maximum levels.

Keywords: Jameed - chemical, Microbial analysis - Rheological measurements

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Contribution/ Originality

This study is one of the very few studies in jameed and the first almost in the study of work forms of jameed and study the effect of shape on the rheological properties and chemical and microbial composition and microscopic for this product, Subsequently, add a new to this product, which is largely consumed in jordan and Egypt recently to manufacture meal "Mansaf".

1. INTRODUCTION

Fermented foods are in general more attractive to the consumer than non-fermented products. They play an important role in the diets of many people in Asia, Near East, parts of Africa and rest of the world (Van and Steinkraus, 1970). Experience and ingenuity have taught the people of the Middle East how to manufacture safe dry fermented milk products (Rosenthal *et al.*, 1980). The best example for these dried products is jameed.

Jameed is a fermented dried dairy product in the form of stone hard balls or other shapes. It has a long history with the Bedouin life style and had long been known for its easy preparation and storage for future use. Jameed is widely used as a common traditional food in several Mediterranean countries including Jordan, Syria, Saudi Arabia, Iraq and Egypt. Several names are being given to jameed, i.e. oggott in Arab Gulf States and jameed in Jordan and Syria. Jameed is produced by produced by straining the heated buttermilk on cloth mesh bags, salting the formed paste by kneading, shaping and drying in the sun (Mazahreh *et al.*, 2008; Quasem *et al.*, 2009). This product is

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reconstituted after disintegration to be used in the preparation of Mansaf, the national dish in Jordan, which is basically lamb meat cooked in Jameed sauce and served on cooked rice. The sauce is made by adding cooked meat to dissolving jameed (reconstituted with warm water) then boiling the mixture for about 15 min, the produced sauce is named "sharap" (Al-Saed *et al*., 2012). The reconstitution of Jameed is a tedious work since the product is difficult to break and to disperse, and the dispersion often lacks stability.

Jameed is usually prepared from sheep buttermilk. However, buttermilk from other sources such as goat, cow and camel (Yagil, 1982) can also be utilized for preparation of jameed. The final jameed product is un-hygroscopic and can be stored in cloth bags or sealed jars for two years without any detectable change (Robinson and Cadena, 1978). The low moisture content and low pH are safeguards against spoilage of jameed and the growth of microorganisms. Supporting to this view, McCarthy and Wood (1985) stated that jameed can be categorized as a cheese product with a long shelf life made by fermenting and drying of milk. It is a shelf-stable dairy product because it has a combination of high salt, pH and low moisture content, and has lactic acid bacteria that minimize the growth of pathogenic microorganisms. Jameed can be stored for several years at room temperature without deterioration and losing of its biological, functional and nutritional values. As a general, jameed is manufactured during the surplus milk season (spring) as a means of preserving the milk and it plays a large role in the nutritional well-being of the local population during periods of the year when fresh milk is not available.

Thus, the aim in this study can be summarized to investigate the chemical composition, rheological and microbial properties of jameed made from goat or cow skim milk with various forms (ball, triangle, square and cylinder).

2. MATERIALS AND METHODS

2.1. Materials

Fresh sheep's, goat's and cow's milks were obtained from El-Serw Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Egypt. A commercial classic yoghurt starter containing *Streptococcus thermophillus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* (1:1) (Chr. Hansen's Lab A/S Copenhagen, Denmark) was used. Starter cultures were in freeze-dried direct-to-vat set form and stored at −18°C until used. Dry commercial food grade sodium chloride obtained from El-Nasr Salines Company, Egypt, was used during this investigation.

3. METHODS

3.1. Production of Jameed in Various Forms

Jameed treatments were made according to the traditional method described by Quasem *et al.* (2009) Figure 1. Traditionally, jameed is manufactured in ball shape, to break this rule, to introduce a new jameed may be more attractive and to facility pouring off moisture, jameed was prepared in triangle, square and cylinder forms. The weight and square area of all jameed forms were equal to minimize the differences between various treatments. Jameed was prepared as described in part 1 and manually shaped into balls whereas triangles, squares and cylinder forms were made by pressing the jameed paste in the molds using hydraulic compressor for one hour. Jameed samples were as follow:

- Treatment A: Jameed made from sheep butter milk (control) with ball form.
- Treatment B: Jameed made from goat skim milk with ball form.
- Treatment C: Jameed made from goat skim milk with triangle form.
- Treatment D: Jameed made from goat skim milk with square form.
- Treatment E: Jameed made from goat skim milk with cylinder form.
- Treatment F: Jameed made from cow skim milk with ball form.
- Treatment G: Jameed made from cow skim milk with triangle form.

- Treatment H: Jameed made from cow skim milk with square form.
- Treatment I: Jameed made from cow skim milk with cylinder form.

The shaped jameed samples were placed on trays lined with cheesecloth and dried in the shade for 24h thin direct sun to constant weigh (~15 days). The dried jameed treatments were packaged in polyethylene bags and stored at room temperature 6 months. Samples were analyzed when fresh and after 15, 30, 60, 90, 120, 150 and 180 days of storage period.

3.2. Yield

Jameed yield was calculated by two means as follows:

Yield-1 (%) = Weight of jameed at the end of storage / Weight of milk used to make jameed x 100

Yield-2 (%) = Weight of jameed at the end of storage / Weight of jameed paste (before drying) x 100

3.3. Chemical Analysis

Total solids, fat, total nitrogen and ash contents of samples were determined according to the AOAC (2000). Titratable acidity in terms of % lactic acid was measured by titrating 10g of sample mixed with 10ml of boiling distilled water against 0.1 N NaOH using a 0.5% phenolphthalein indicator to an end point of faint pink color (Parmar, 2003). The pH of the sample was measured at 17 to 20°C using a pH meter (Corning pH/ion analyzer 350, Corning, NY) after calibration with standard buffers (pH 4.0 and 7.0). Water soluble nitrogen (WSN) and non-protein-nitrogen (NPN) of jameed were estimated according to Ling (1963). The Volhard's method as described by Richardson (1985) was used to determine the salt content of jameed. Salt in moisture percentage of the cheese was estimated as follow:

(Salt percentage x 100) / (moisture percentage + Salt percentage)

3.4. Microbiological Analyses

Jameed samples were analyzed for total viable bacterial count (TVBC), lactic acid bacteria (LAB), coliform, proteolytic bacteria, moulds and yeast counts according to the methods described by the American Public Health Association (1992).

3.5. Textural Measurements

Force and torque measurements of jameed treatments stored for six months were measured using a Texturometer model Mecmesin Emperor ™Lite 1.17(USA). Mechanical primary characteristics of hardness, springiness, gumminess and cohesiveness and also the secondary characteristic of chewiness (hardness x cohesiveness x springiness) were determined from the deformation Emperor ™Lite Graph. Because jameed samples were very hard, they were soaked in distilled water for 6h at room temperature before measurements.

3.6. Wetability Test

A cube weighing ca. 45 g of jameed was cut using a hand saw from a whole jameed ball; 315 ml water were added to the piece placed in 500 ml cup and soaked for 24 h (Quasem *et al.*, 2009). The excess free water was carefully decanting weighed to calculate the soaked amount as follows:

Absorbed water (%) = [(315 ml water-X) /Weight of cubs in g] x 100

X= the weight of excess water in g.

3.7. Syneresis (Whey Separation) Test

The soaked cube (45 g) was mixed with (315 ml water) for 2 minutes using electrical hand mixer (Hinari, model FM2, China) with the whipping accessory. The dispersed jameed was transferred to a 100 ml graduated cylinder and the clear zone was measured after 1 h and 24 h (Quasem *et al.*, 2009). Syneresis (whey separation) was calculated, as follow:

Syneresis (%) = (X/Y) ×100 Where; X= the height of the clear zone and Y= total height of jameed dispersion.

3.8. Scanning Electron Microscopy (SEM) Examination

Jameed samples were prepared for SEM according to the method of Brooker and Wells (1984). The specimens were viewed in a scanning electron microscope (JXA-840A Electron Probe Microanalyzer-JEOL-Japan) after dehydrated using Critical Point Dried instrument and coating with gold using S150A Sputter Coater-Edwards England.

3.9. Statistical Analysis

The obtained results were statistically analyzed using a software package (SAS, 1991) based on analysis of variance. When F-test was significant, least significant difference (LSD) was calculated according to Duncan (1955) for the comparison between means. The data presented, in the tables, are the mean (± standard deviation) of 3 experiments.

4. RESULTS AND DISCUSSION

4.1. Chemical Composition of Milk Used in Jameed Manufacture

Chemical composition of sheep buttermilk, goat and cow skim milk used in jameed production was presented in Table 1.

Table-1. Chemical composition of milk used in jameed manufacture

Treatments	Acidity %	pH values	TS %	Fat %	TP %	SNF %
Whole sheep's milk	0.20^{b}	6.45^{a}	18.13^{a}	8.7^{a}	5.22^{a}	9.43^{a}
Sheep buttermilk	0.99^{a}	5.92^{b}	7.81^{de}	0.7^{c}	5.10^{a}	6.50^{ab}
Whole goat's milk	0.16^{b}	6.60^{a}	12.95^{b}	4.3^{b}	3.44^{a}	8.65^{ab}
Goat buttermilk	0.93^{a}	6.15^{b}	6.61^{e}	0.6^{c}	3.20^{a}	6.11^{b}
Goat skim milk	0.17^{b}	6.60^{a}	9.97^{dbc}	0.9^{c}	3.05^{a}	9.07^{ab}
Whole cow's milk	0.16^{b}	6.62^{a}	12.21^{bc}	3.6^{b}	3.37^{a}	8.61^{ab}
Cow buttermilk	0.90^{a}	6.19^{b}	6.71^{de}	0.5^{c}	3.25^{a}	6.21^{ab}
Cow skim milk	0.18^{b}	6.58^{a}	9.47d^{ec}	0.4^{c}	2.98^{a}	8.97^{ab}

[abcde] Letters Indicate Significant Differences between Milk Treatments

Sheep butter milk had the highest acidity content and the lowest pH values. On the contrary, total solids (TS) and solids-not-fat (SNF) levels were higher in goat and cow skim milk than that of sheep butter milk. Fat concentration of goat skim milk was the highest as compared with those found in sheep buttermilk or cow skim milk. Sheep butter milk is richer in total protein (TP%) than goat or cow skim milk.

4.2. Changes in Moisture Content of Jameed during Solar Drying Process

After partially drying of jameed treatments at different temperatures and times in electricity oven, drying process was completed in sun till moisture content of jameed reached to ~20%. To determine the end of solar drying stage, the moisture contents were followed in jameed paste and after 3, 5, 7, 9, 11, 13 and 15 days of solar drying period. Results are shown in Table 2. Moisture values of jameed made from goat or cow skim milk and dried in sun (samples B and G respectively) were higher than jameed prepared from sheep butter milk with sun drying (sample A). As expected, moisture levels at the beginning and within drying period of samples A, B and G were higher than other treatments. Utilization of partially drying after shaping of jameed paste significantly ($p<0.05$) reduced moisture concentrations. The reduction rates were proportional with increasing of drying temperatures.

Consequently, samples of goat skim milk jameed dried at 90ºC/6h (sample F) reached to ~20% moisture at the seventh day of drying period while samples dried at 75ºC/8h, 60ºC/10h and 45ºC/12h reached after 9, 9 and 13 days of drying respectively. The same trend but with faster levels was observed in cow skim milk jameed. Treatments dried at 90ºC/6h, 75ºC/8h, 60ºC/10h and 45ºC/12h (samples K, J, I, and H respectively) recoded 20% moisture after 7, 7, 9 and 11 days of drying stage. This main that the time of solar drying period reduced by 53.33, 53.33, 40.00 and 26.67% for the mentioned above samples respectively. Moisture levels were a little bit lower in cow skim milk jameed than that of goat skim milk one. Generally, the highest levels of moisture losing were noticed in the first five days of drying process.

Table-2. Moisture content of jameed samples during solar drying process

Treatments	Solar drying process (days)							
	Fresh	3	5	7	9	11	13	15
A	51.33^{c}	43.72^{c}	37.37^{c}	32.68^{b}	28.89^{b}	24.16^{b}	21.56^{b}	18.00^{b}
B	68.11^{a}	56.68^{a}	49.14^{a}	42.02^{a}	37.16^{a}	31.56^{a}	27.47^{a}	24.21^{a}
C	33.20^{d}	30.08^{d}	27.90^{d}	25.42^{cd}	23.25^{c}	21.30^{c}	19.04^{c}	-
D	31.00^{e}	28.33^{e}	25.00^{e}	22.08^{d}	20.10^{e}	-	-	-
E	28.77^{f}	26.07^{f}	24.98^{e}	21.15^{de}	19.37^{e}	-	-	-
F	27.00^{g}	25.73^{fg}	22.06^{f}	20.07^{e}	-	-	-	-
G	65.86^{b}	54.12^{b}	47.88^{b}	41.67^{a}	36.53^{a}	31.23^{a}	26.76^{a}	23.76^{a}
H	32.60^{de}	30.66^{d}	28.05^{d}	26.34^{c}	22.74^{d}	19.58^{d}	-	-
I	30.03^{ef}	27.80^{e}	24.77^{e}	21.03^{de}	19.94^{e}	-	-	-
J	27.64^{fg}	25.33^{fg}	23.96^{ef}	20.69^{e}	-	-	-	-
K	26.33^{g}	24.05^{g}	22.11^{f}	20.08^{e}	-	-	-	-

^{abcde} Letters indicate significant differences between milk treatments

Treatment A: Jameed made from sheep butter milk (control) with sun drying (traditional method).

Treatment B: Jameed made from goat skim milk with sun drying (traditional method).

Treatment C: Jameed made from goat skim milk and dried at 45ºC/12h.

Treatment D: Jameed made from goat skim milk and dried at 60ºC/10h.

Treatment E: Jameed made from goat skim milk and dried at 75ºC/8h.

Treatment F: Jameed made from goat skim milk and dried at 90ºC/6h.

Treatment G: Jameed made from cow skim milk with sun drying (traditional method).

Treatment H: Jameed made from cow skim milk and dried at 45ºC/12h.

Treatment I: Jameed made from cow skim milk and dried at 60ºC/10h.

Treatment J: Jameed made from cow skim milk and dried at 75ºC/8h.

Treatment K: Jameed made from cow skim milk and dried at 90ºC/6h.

4.3. Yield of Jameed

The definition of cheese yield, or how to express yield, is important in two main applications: 1. economic control of cheesemaking; 2. expressing the results of cheesemaking experiments. Cheese yield is affected by many factors including milk composition, amount and genetic variants of casein, milk quality, somatic cell count (SCC) in milk, milk pasteurization, coagulant type, vat design, curd firmness at cutting, and manufacturing parameters (Abd El-Gawad and Ahmed, 2011). Outcomes of jameed yield as affected by various shapes are presented in Table 3. Values of yield-1 and yield-2 of sheep buttermilk jameed were very higher than jameed prepared from goat and cow skim milk while jameed yield levels were similar for goat or cow skim milk. On the other hand, yield-1 and yield-2 levels of ball, triangle and square jameed were close to each other. Yield of cylindrical shape jameed were slightly higher.

Table-3. Effect of jameed form on yield values

Treatments	Yield-1	Yield-2
A	16.03^{a}	54.66^{a}
B	7.57^{b}	39.33^{c}
C	7.38^{b}	38.51^{c}
D	7.56^{b}	39.47^{c}
E	7.81^{b}	40.75^{c}
F	6.80^{bc}	40.84^{c}
G	6.82^{bc}	40.81^{c}
H	6.98^{b}	41.78^{b}
I	7.07^{b}	42.28^{b}

Treatment A: Jameed made from sheep buttermilk (control) with ball form.

Treatment B: Jameed made from goat skim milk with ball form.

Treatment C: Jameed made from goat skim milk with triangle form.

Treatment D: Jameed made from goat skim milk with square form.

Treatment E: Jameed made from goat skim milk with cylinder form.

Treatment F: Jameed made from cow skim milk with ball form.

Treatment G: Jameed made from cow skim milk with triangle form.

Treatment H: Jameed made from cow skim milk with square form.

Treatment I: Jameed made from cow skim milk with cylinder form.

4.4. Physico-Chemical Properties of Jameed during Storage Period

Data cleared in Table 4 compare between the titratable acidity (% lactic acid), pH, total solids (TS) and fat contents of jameed made from sheep buttermilk, goat and cow skim milk using different molds. During the storage period, titratable acidity values of various jameed treatments tended to increase while pH values tended to decrease. The highest increasing rates or the lowest decreasing levels were observed in the first month of storage. These results may be due to acid production in jameed during storage as a result of lactose fermentation. Sheep buttermilk jameed had higher acidity ratios than jameed prepared from goat or cow skim milk. Also, the highest values of the acidity development rates during storage were higher in the former than those of the latter. Goat skim milk jameed possessed slightly higher acidity values than cow skim milk jameed. Very slight decreasing in acidity values was noted as a result of change jameed shape from ball to triangle, square and cylinder. The lowest acidity levels were detected in cylindrical form jameed. The acidity values of treatments A, B, E, F and I after 60 days of storage were 4.46, 3.58, 3.65, 3.38 and 3.33% respectively.

Total solids values of goat skim milk jameed were similar to those of jameed made from cow skim milk but were lower than sheep buttermilk jameed. Goat skim milk jameed had the highest fat values followed by sheep buttermilk and cow skim milk jameed. Generally, TS and fat contents of different jameed treatments gradually increased within storage period. The highest rates of increases were found at the end of solar drying stage (after 15 days). As it is showed in Table 4, molds shape had a significant effect ($p<0.05$) on TS and fat contents of jameed. Utilization of square and cylinder molds in jameed manufacturing significantly ($p<0.05$) lowered TS and fat values. The lowering levels were clearer in cylindrical shape jameed. On the other side, TS and fat concentrations in both ball and triangle forms jameed were close to each other. Total solids concentrations of samples A, B, C, D, E, F, G, H and I at the end of storage period were 89.06, 82.95, 82.80, 80.79, 78.24, 83.78, 83.64, 81.69 and 80.74% respectively.

Total protein, ash, salt and salt in moisture values of sheep buttermilk jameed were higher than goat and cow skim milk one (Table 4). Using cow skim milk in jameed production increased total protein whereas decreased ash contents as compared with jameed made from goat skim milk. No clear differences were observed in salt and salt in moisture contents between jameed made from goat or cow skim milk. Salt levels of samples A, B, C, F and G were

10.87, 10.45, 10.85, 10.20, 10.43% after 120 days of storage period respectively. The influence of mold shape on total protein and ash contents of jameed was similar to that on TS and fat. Square and cylinder jameed contained the lowest total protein and ash levels. The values of these components were similar in ball or triangle jameed. Salt levels of ball, triangle, square and cylinder jameed were comparable. However, salt in moisture values of square and cylinder jameed were lower than that made in ball and triangle molds. Through storage period, total protein, ash salt and salt in moisture contents gradually increased in all jameed samples.

Results of chemical composition of jameed in our study were slightly lower than those reported by (Abu-Lehia, 1987) and within ranges found by (Tawalbeh, 1992; Jumah *et al.*, 2000). Abu-Lehia (1987) reported that jameed from goat milk contains 9.1% moisture, 19.6% fat, 50.0% total protein, 13.0% ash and 8.1% carbohydrate. Tawalbeh (1992) reported that jameed from sheep and goat, respectively, contain 4.7 and 5.6% acidity, 11.0 and 10.8% salt, 91.5 and 91.1% total solids, 19.7 and 31.7% fat, 51.4 and 39.3% protein, 3.1 and 3.8% non-protein nitrogen, 2.1 and 1.2% lactose, and 13.2 and 12.3% ash. Jumah *et al.* (2000) reported that the chemical composition of spray-dried jameed was in the range of 7.9–28.3% moisture, 16.9– 19.6% fat and 40.2–63.4% protein.

The changes in water soluble nitrogen (WSN), WSN/TN, non-protein-nitrogen, NPN/TN contents of jameed during storage are presented in Table 4. Type of milk used in jameed manufacture greatly affected the mentioned contents. Jameed made from goat or cow skim milk possessed lower WSN and NPN levels than those of jameed made from sheep buttermilk. Values of WSN/TN and NPN/TN took the same trend through storage period but the opposite was occurred for jameed paste (fresh). Concentrations of WSN for samples A, B and F after 60 days of storage were 1.463, 1.222 and 1.193% respectively. Increasing of protein content in sheep buttermilk and consequently in jameed and also increasing bacterial activity may be the reasons which caused rising of WSN and NPN levels in sheep buttermilk jameed as compared with goat and cow skim milk jameed.

Levels of WSN and NPN of jameed shaped as square and cylinder were lower than those of ball and triangle jameed. On the contrary, WSN/TN and NPN/TN values were higher in the former than the latter. Contents of WSN in treatments F, G, H and I after 150 days of storage were 1.230, 1.233, 1.226 and 1.222% respectively. Respective values for WSN/TN were 15.70, 15.79, 16.13 and 16.45% respectively. Irrespective of milk type or jameed form, WSN, WSN/TN, NPN and NPN/TN values gradually increased with the advanced of storage stage in different jameed treatments. Of course this attributed to the proteolytic bacteria activity.

Table-4. Effect of jameed form on some physico-chemical properties

Properties	Treatments	Storage period (days)								Means
		Fresh	15	30	60	90	120	150	180	
Acidity %	A	2.05	3.48	4.11	4.46	4.78	5.01	5.25	5.36	4.32^{a}
	B	1.82	2.78	3.27	3.58	3.88	4.07	4.30	4.40	3.48^{ab}
	C	1.82	2.80	3.26	3.60	3.87	4.05	4.29	4.41	3.51^{ab}
	D	1.82	2.77	3.24	3.57	3.86	4.06	4.28	4.39	3.50^{ab}
	E	1.82	2.75	3.23	3.56	3.85	4.05	4.27	4.37	3.49^{ab}
	F	1.72	2.60	3.10	3.38	3.62	3.83	3.96	4.08	3.25^{b}
	G	1.72	2.59	3.10	3.37	3.63	3.82	3.95	4.07	3.28^{b}
	H	1.72	2.58	3.09	3.35	3.60	3.82	3.95	4.06	3.33^{ab}
	I	1.72	2.56	3.06	3.33	3.60	3.81	3.94	4.05	3.25^{b}
	Means	1.82^{D}	2.76^{C}	3.32^{CB}	3.57^{CAB}	3.84^{AB}	4.04^{AB}	4.23^{AB}	4.34^{A}	
pH values	A	4.98	4.43	4.19	3.91	3.70	3.55	3.41	3.36	3.94^{a}
	B	5.32	4.61	4.45	4.32	4.11	4.05	3.96	3.87	4.37^{a}
	C	5.32	4.60	4.44	4.30	4.14	4.07	3.97	3.86	4.33^{a}
	D	5.32	4.63	4.47	4.33	4.13	4.07	3.97	3.89	4.35^{a}
	E	5.32	4.65	4.47	4.34	4.14	4.08	3.98	3.91	3.61^{a}
	F	5.41	4.71	4.49	4.38	4.32	4.23	4.18	4.06	4.50^{a}
	G	5.41	4.73	4.50	4.40	4.30	4.24	4.17	4.08	4.48^{a}
	H	5.41	4.72	4.51	4.39	4.35	4.25	4.20	4.08	4.49^{a}
	I	5.41	4.74	4.53	4.41	4.36	4.26	4.21	4.11	4.50^{a}
	Means	5.30^{A}	4.67^{AB}	4.46^{AB}	4.32^{B}	4.18^{B}	4.10^{B}	4.02^{B}	3.92^{B}	
	A	48.67	82.00	84.95	86.12	87.08	87.87	88.58	89.06	81.79^{a}
	B	31.89	75.79	78.14	79.10	81.11	82.15	82.21	82.95	82.04^{a}

TS %	**C**	31.89	76.15	78.12	79.25	80.92	82.10	82.32	82.80	74.20^{b}
	D	31.89	72.67	75.55	76.64	78.19	79.74	80.01	80.79	71.81^{c}
	E	31.89	71.23	74.30	75.34	76.37	77.41	77.84	78.24	70.39^{d}
	F	34.14	76.24	79.12	80.26	81.33	82.46	82.97	83.78	82.44^{a}
	G	34.14	77.10	78.95	80.02	81.10	82.50	82.88	83.64	75.04^{b}
	H	34.14	73.45	76.68	78.72	79.79	80.82	81.12	81.69	73.93^{b}
	I	34.14	72.70	75.81	77.84	78.86	79.87	80.25	80.74	72.53^{c}
	Means	42.88^{F}	76.54^{E}	79.04^{D}	80.35^{C}	81.35^{CB}	82.17^{AB}	82.63^{A}	83.18^{A}	
Fat %	**A**	3.85	10.40	10.64	10.87	11.05	11.14	11.23	11.35	10.06^{ab}
	B	4.19	11.36	11.57	11.71	11.84	11.98	12.20	12.35	10.92^{a}
	C	4.19	11.27	11.73	11.80	11.93	12.17	12.25	12.42	10.97^{a}
	D	4.19	10.65	10.87	10.94	11.16	11.29	11.37	11.49	10.25^{ab}
	E	4.19	9.65	9.87	9.97	10.12	10.34	10.41	10.62	9.40^{b}
	F	3.17	9.90	9.95	10.19	10.31	10.40	10.49	10.60	9.88^{b}
	G	3.17	9.83	9.90	10.15	10.37	10.61	10.70	10.85	9.45^{b}
	H	3.17	8.19	8.33	8.56	8.79	8.92	9.03	9.24	8.03^{c}
	I	3.17	7.00	7.13	7.34	7.55	7.70	7.86	7.98	6.97^{d}
	Means	4.40^{A}	9.78^{A}	9.97^{A}	10.14^{A}	10.32^{A}	10.47^{A}	10.57^{A}	10.71^{A}	
Total protein %	**A**	29.55	51.13	53.05	53.16	53.31	53.61	53.70	53.81	50.17^{b}
	B	14.95	43.91	47.01	47.34	47.45	47.66	47.78	47.92	51.66^{a}
	C	14.95	43.45	47.55	47.78	47.87	47.91	47.96	48.07	43.19^{d}
	D	14.95	40.54	45.10	45.35	45.44	45.50	45.60	45.72	41.03^{e}
	E	14.95	38.70	44.83	45.20	45.31	45.37	45.47	45.64	40.68^{e}
	F	17.24	47.11	49.23	49.54	49.69	49.87	49.99	50.28	52.19^{a}
	G	17.24	47.32	49.38	49.43	49.52	49.67	49.85	49.97	45.30^{c}
	H	17.24	45.00	48.12	48.17	48.29	48.40	48.51	48.63	44.05^{d}
	I	17.24	44.65	46.94	47.00	47.15	47.29	47.42	47.55	43.16^{d}
	Means	23.87^{C}	46.03^{B}	48.95^{A}	49.14^{A}	49.26^{A}	49.38^{A}	49.49^{A}	49.60^{A}	
Ash %	**A**	11.50	14.87	14.95	15.38	15.59	15.81	16.04	16.14	15.04^{a}
	B	10.14	13.57	13.81	13.97	14.31	14.47	14.60	14.74	14.41^{ab}
	C	10.14	13.78	13.97	14.11	14.21	14.30	14.38	14.53	13.74^{bc}
	D	10.14	12.53	12.81	12.96	13.47	13.60	13.82	14.01	12.92^{dce}
	E	10.14	12.12	12.56	12.87	13.24	13.38	13.51	13.66	12.69^{e}
	F	9.97	13.30	13.57	13.69	13.94	14.27	14.49	14.64	14.40^{ab}
	G	9.97	13.80	13.99	14.10	14.26	14.34	14.51	14.67	13.71^{dcb}
	H	9.97	12.71	12.89	13.12	13.28	13.41	13.60	13.78	12.85^{dce}
	I	9.97	12.68	12.71	12.97	13.10	13.25	13.43	13.69	12.73^{de}
	Means	10.73^{C}	13.47^{B}	13.64^{B}	13.84^{AB}	14.05^{AB}	14.18^{AB}	14.36^{AB}	14.58^{A}	
Salt %	**A**	7.02	10.23	10.58	10.62	10.78	10.87	10.95	11.07	10.27^{ab}
	B	6.40	9.72	10.11	10.25	10.39	10.45	10.51	10.57	10.98^{a}
	C	6.40	9.93	10.57	10.65	10.78	10.85	10.90	10.98	10.13^{ab}
	D	6.40	9.28	10.33	10.46	10.59	10.62	10.74	10.89	9.91^{b}
	E	6.40	9.00	10.10	10.23	10.35	10.49	10.58	10.73	9.74^{b}
	F	5.88	9.61	9.70	10.07	10.12	10.20	10.33	10.42	11.08^{a}
	G	5.88	9.19	9.42	10.05	10.30	10.43	10.56	10.67	9.56^{b}
	H	5.88	9.50	9.59	10.10	10.26	10.39	10.47	10.53	9.59^{b}
	I	5.88	9.05	9.15	10.20	10.34	10.47	10.60	10.73	9.55^{b}
	Means	6.83^{C}	9.77^{B}	10.22^{AB}	10.55^{AB}	10.70^{AB}	10.80^{A}	10.88^{A}	10.98^{A}	
WSN %	**A**	0.468	1.401	1.435	1.463	1.478	1.492	1.510	1.521	1.346^{a}
	B	0.450	1.187	1.194	1.222	1.237	1.245	1.260	1.272	1.260^{a}
	C	0.450	1.189	1.192	1.225	1.239	1.248	1.261	1.275	1.130^{a}
	D	0.450	1.174	1.186	1.214	1.230	1.242	1.257	1.268	1.128^{a}
	E	0.450	1.170	1.181	1.209	1.228	1.238	1.254	1.264	1.124^{a}
	F	0.441	1.159	1.177	1.193	1.206	1.217	1.230	1.242	1.238^{a}
	G	0.441	1.162	1.178	1.194	1.205	1.218	1.233	1.240	1.109^{a}
	H	0.441	1.157	1.171	1.186	1.198	1.211	1.226	1.235	1.103^{a}
	I	0.441	1.154	1.168	1.181	1.195	1.207	1.222	1.230	1.099^{a}
	Means	0.544^{A}	1.213^{A}	1.229^{A}	1.252^{A}	1.265^{A}	1.277^{A}	1.291^{A}	1.300^{A}	
WSN/TN %	**A**	10.10	17.49	17.26	17.56	17.70	17.76	17.95	18.04	16.73^{cb}
	B	19.23	17.25	16.20	16.44	16.55	16.67	16.82	16.94	15.50^{de}
	C	19.23	17.43	16.00	16.38	16.52	16.62	16.76	16.89	16.98^{cab}
	D	19.23	18.49	16.78	17.10	17.28	17.42	17.64	17.68	17.70^{ab}
	E	19.23	19.27	16.82	17.08	17.30	17.41	17.59	17.68	17.80^{a}
	F	16.33	15.70	15.24	15.37	15.48	15.56	15.70	15.76	15.08^{e}
	G	16.33	15.66	15.22	15.41	15.40	15.55	15.79	15.84	15.65^{de}
	H	16.33	16.41	15.53	15.70	15.84	15.96	16.13	16.21	16.01^{cde}
	I	16.33	16.48	15.87	16.02	16.17	16.29	16.45	16.51	16.73^{cd}
	Means	15.77^{B}	16.91^{A}	16.03^{AB}	16.27^{AB}	16.40^{AB}	16.50^{AB}	16.67^{AB}	16.74^{A}	

NPN %	**A**	0.089	0.271	0.280	0.290	0.298	0.310	0.317	0.325	0.272^{a}
	B	0.078	0.240	0.249	0.256	0.261	0.269	0.273	0.278	0.256^{a}
	C	0.078	0.244	0.248	0.257	0.260	0.270	0.274	0.279	0.239^{a}
	D	0.078	0.237	0.244	0.251	0.255	0.267	0.269	0.275	0.234^{a}
	E	0.078	0.235	0.241	0.250	0.252	0.265	0.267	0.271	0.232^{a}
	F	0.077	0.250	0.259	0.266	0.273	0.279	0.285	0.293	0.245^{a}
	G	0.077	0.253	0.260	0.268	0.274	0.278	0.286	0.292	0.249^{a}
	H	0.077	0.245	0.255	0.261	0.270	0.274	0.282	0.288	0.244^{a}
	I	0.077	0.241	0.252	0.259	0.266	0.270	0.280	0.285	0.241^{a}
	Means	0.092^{B}	0.245^{A}	0.255^{A}	0.262^{A}	0.268^{A}	0.276^{A}	0.281^{A}	0.287^{A}	
NPN/TN %	**A**	1.92	3.38	3.36	3.48	3.56	3.69	3.76	3.85	3.38^{a}
	B	3.33	3.49	3.38	3.45	3.51	3.60	3.64	3.70	3.13^{a}
	C	3.33	3.58	3.33	3.44	3.47	3.60	3.64	3.70	3.51^{a}
	D	3.33	3.73	3.45	3.54	3.58	3.74	3.76	3.84	3.69^{a}
	E	3.33	3.87	3.43	3.53	3.55	3.73	3.74	3.79	3.62^{a}
	F	2.59	3.39	3.35	3.42	3.50	3.57	3.64	3.72	2.75^{a}
	G	2.85	3.41	3.36	3.46	3.53	3.57	3.66	3.73	3.44^{a}
	H	2.85	3.48	3.38	3.46	3.57	3.61	3.71	3.78	3.48^{a}
	I	2.85	3.44	3.42	3.51	3.60	3.64	3.77	3.83	3.51^{a}
	Means	2.71^{B}	3.45^{AB}	3.29^{AB}	3.37^{AB}	3.44^{AB}	3.53^{AB}	3.65^{A}	3.66^{A}	

^{abcde} Letters indicate significant differences between jameed treatments

^{ABCD} Letters indicate significant differences between storage times

4.5. Changes in Microbial Counts of Jameed during Storage

The outcomes in Table 5 clear the changes in counts of total viable bacterial count (TVBC), lactic acid bacteria, proteolytic bacteria and moulds and yeasts of various jameed treatments during storage period. It could be noticed that the counts of TVBC significantly ($p< 0.05$) increased in jameed made from sheep buttermilk (treatment A) comparing with that made from goat and cow skim milk (treatments B and F respectively). Cow skim milk jameed had the lowest TVBC among various samples. The very antithesis, the highest loss of survival levels of TVBC during storage period were detected in cow milk jameed followed by goat skim milk and sheep buttermilk jameed. Values of loss of survival for samples A, B, and F were 85.07, 87.93 and 90.00% respectively. On the other hand, lowering of nutrients such as fat, protein and ash in square and cylinder forms jameed caused decreasing of TVBC. Ball and triangle shapes nearly contained the same TVBC. Also the counts of lactic acid bacteria increased in sheep buttermilk jameed and decreased in that prepared from cow skim milk. Their numbers in goat skim milk jameed were at an intermediate position. Add to that, goat skim milk jameed had lower levels of survival loss during storage than cow skim milk jameed but were higher than those of sheep buttermilk jameed. Like decreasing of TVBC in square and cylinder jameed, also lactic acid bacteria numbers reduced. The cylindrical jameed possessed the lowest counts between various samples. On the whole, lactic acid bacteria represented the majority of TVBC in all jameed treatments.

Regarding the counts of proteolytic bacteria in different jameed treatments, sheep buttermilk jameed scored the highest counts followed by jameed prepared from goat skim milk and in the end of the order jameed made from cow skim milk. Shape of molds used in jameed production also affected the proteolytic bacteria numbers. The cylindrical jameed had the lowest counts while the spherical jameed had the highest. In different jameed samples, there were significant ($p<0.05$) lowering in TVBC, lactic acid bacteria and proteolytic bacteria during storage. The main metabolic products of carbohydrate fermentation by bacteria activity are organic acids substantiated by a drop in pH of the surrounding environment. This statement was approved in different cheese varieties by the studies of many authors. Shehata *et al.* (2004) found that yeast and moulds, proteolytic, psychrophilic and viable spore forming bacterial counts significantly decreased along the ripening period of Ras cheese. Andrade *et al.* (2008) reported that the dynamic of starter LAB during Cheddar ripening showed that lactococci, represented by *Lc. lactis*, *Lc. cremoris* and *Lc. diacetylactis*, have a gradual decline, resulting in 2 log reduction after 6 month. *Lb. casei* increased significantly during the first month and showed a slight decrease after 6 month. Conversely, *Lb. bulgaricus* population showed a rapid increase after inoculation, followed by a drastic reduction, indicative of autolytic activity, during the first month. At the ninety day of storage, moulds and yeasts appeared in samples A, B, C, F and G. After that, they were detected in all jameed treatments. On the whole, findings of moulds and yeasts showed the exactly same trend of TVBC, lactic acid bacteria and proteolytic bacteria. Sheep buttermilk jameed had the greatest and cow skim milk jameed possessed the lowest. Ball and triangle jameed contained higher counts than jameed formed in square and cylinder shapes.

Table-5. Effect of jameed form on some microbial groups

Properties	Treatments	Storage period (days)								Means
		Fresh	15	30	60	90	120	150	180	
TVBC (x 10^3)	A	67	35	29	22	18	15	13	10	26.13^{a}
	B	58	25	20	15	14	13	9	7	20.13^{b}
	C	58	23	19	17	13	11	8	5	19.25^{b}
	D	58	21	16	12	11	8	5	3	16.75^{c}
	E	58	19	15	10	9	6	4	1	15.25^{d}
	F	50	18	17	15	10	8	6	5	16.13^{cd}
	G	50	16	18	14	9	7	5	3	15.25^{d}
	H	50	15	15	11	8	6	4	1	13.75^{e}
	I	50	13	12	9	6	3	1	0.09	11.76^{f}
	Means	55.44^{A}	20.56^{B}	17.89^{C}	13.89^{D}	10.89^{E}	8.56^{F}	6.11^{G}	3.90^{H}	
Lactic acid bacteria (x 10^3)	A	55	28	21	16	13	10	9	8	20.00^{a}
	B	44	20	15	10	9	8	6	3	14.38^{b}
	C	44	21	14	9	7	6	4	2	13.38^{c}
	D	44	19	12	8	5	3	1	0.7	11.59^{de}
	E	44	15	11	6	3	1	0.9	0.5	10.24^{f}
	F	38	16	13	10	9	5	3	0.6	11.83^{d}
	G	38	15	13	9	6	4	1	0.7	10.84^{fe}
	H	38	12	9	6	4	1	0.9	0.5	8.93^{g}
	I	38	9	7	4	1	0.8	0.6	0.3	7.59^{h}
	Means	42.56^{A}	17.22^{B}	12.83^{C}	8.67^{D}	6.33^{E}	4.31^{F}	2.93^{G}	1.81^{H}	
Proteolytic bacteria (x 10^3)	A	6	0.9	0.7	0.3	0.10	0.08	0.05	0.05	1.023^{a}
	B	4	0.6	0.4	0.07	0.06	0.04	0.03	0.01	0.651^{b}
	C	4	0.7	0.4	0.06	0.04	0.03	0.01	0.009	0.657^{b}
	D	4	0.5	0.3	0.01	0.009	0.008	0.006	0.004	0.604^{b}
	E	4	0.4	0.2	0.01	0.008	0.006	0.005	0.003	0.580^{b}
	F	3	0.2	0.09	0.08	0.05	0.04	0.03	0.01	0.438^{b}
	G	3	0.2	0.08	0.06	0.04	0.03	0.02	0.009	0.430^{b}
	H	3	0.1	0.07	0.009	0.008	0.007	0.004	0.002	0.400^{b}
	I	3	0.09	0.05	0.008	0.007	0.005	0.003	0.001	0.395^{b}
	Means	3.78^{A}	0.41^{B}	0.25^{BC}	0.07^{C}	0.34^{C}	0.027^{C}	0.017^{C}	0.01^{C}	
Moulds & Yeast (x10^3)	A	0	0	0	0	0.3	0.4	0.7	0.9	0.288^{a}
	B	0	0	0	0	0.1	0.3	0.6	0.8	0.225^{b}
	C	0	0	0	0	0.1	0.4	0.5	0.8	0.225^{b}
	D	0	0	0	0	0	0.2	0.4	0.6	0.150^{c}
	E	0	0	0	0	0	0.1	0.2	0.4	0.088^{ed}
	F	0	0	0	0	0.09	0.2	0.3	0.5	0.136^{cd}
	G	0	0	0	0	0.08	0.1	0.4	0.5	0.135^{cd}
	H	0	0	0	0	0	0.09	0.1	0.3	0.061^{e}
	I	0	0	0	0	0	0.08	0.09	0.1	0.033^{e}
	Means	0^{E}	0^{E}	0^{E}	0^{E}	0.07^{D}	0.21^{C}	0.37^{B}	0.54^{A}	

Source: Treatment A: Jameed made from sheep buttermilk (control) with ball form.

Treatment B: Jameed made from goat skim milk with ball form.

Treatment C: Jameed made from goat skim milk with triangle form.

Treatment D: Jameed made from goat skim milk with square form.

Treatment E: Jameed made from goat skim milk with cylinder form.

Treatment F: Jameed made from cow skim milk with ball form.

Treatment G: Jameed made from cow skim milk with triangle form.

Treatment H: Jameed made from cow skim milk with square form.

Treatment I: Jameed made from cow skim milk with cylinder form.

4.6. Changes in Solubility of Jameed during Storage

To make jameed edible, it should be first reconstituted in warm water. Wettability and syneresis properties are good indicators for the validity of jameed to reconstitution. Data in Table 6 show the impact of change jameed form on the wettability and syneresis during storage.

As can be seen from Table 6, results of wettability revealed that utilization of sheep buttermilk in jameed manufacture increased its value. The wettability levels of goat skim milk jameed were higher than jameed prepared from cow skim milk. Values of wettability of samples A, B and F after 90 day of storage were 227.12, 215.78 and 212.87% respectively. When comparing between the wettability values of various jameed forms, it is clear that using of triangle mold caused significant ($p<0.05$) increase in jameed wettability. With lesser degree than triangle mold, also square shape raised the jameed wettability within storage period. Both ball and cylinder jameed approximately had the same results of wettability. Values of wettability for treatments F, G, H and I after 120 days of storage were 217.23, 227.00, 223.15 and 218.35% respectively.

Syneresis values of cow skim milk jameed were higher than those of goat skim milk one which were higher than jameed made from sheep buttermilk. Levels of syneresis measured after 1 h of mixing with water for samples A, B and F after 60 days of storage were 48.03, 50.45 and 52.01% respectively. On the other side, triangle jameed followed by square form scored the highest syneresis levels among different shapes. No clear differences were observed between results of syneresis of ball and cylinder jameed. Syneresis values determined after 1 h of mixing with water for samples B, C, D and E after 150 days of storage were 57.66, 69.84, 65.24 and 58.09% respectively. In all jameed treatments, values of syneresis measured after 24 h were higher than those measured after 1 h of mixing with water. Both wettability and syneresis values of different jameed samples gradually increased during storage stage.

Table-6. Effect of jameed form on wettability and syneresis

Properties	Treatments	Storage period (days)							Means
		15	30	60	90	120	150	180	
Wettability (%)	A	210.85	220.73	225.22	227.12	228.79	230.91	233.34	225.28^{a}
	B	196.48	201.36	210.89	215.78	218.33	219.14	221.97	211.99^{a}
	C	207.56	216.08	220.33	223.06	226.32	228.11	230.44	221.70^{a}
	D	202.23	212.45	215.78	218.04	223.67	224.98	226.09	217.53^{a}
	E	195.07	202.88	211.05	214.98	219.67	221.57	222.55	212.54^{a}
	F	191.85	202.88	210.04	212.87	217.23	218.20	219.09	210.31^{a}
	G	205.67	217.02	219.02	222.02	227.00	227.78	230.54	221.29^{a}
	H	203.00	210.62	216.90	219.06	223.15	225.21	227.08	217.86^{a}
	I	192.33	203.85	210.00	211.33	218.35	219.45	221.94	211.04^{a}
	Means	200.56^{A}	209.71^{A}	215.47^{A}	218.25^{A}	222.50^{A}	223.93^{A}	225.89^{A}	
Syneresis % (after 1h of mixing with water)	A	39.84	47.87	48.03	51.97	54.67	55.84	57.22	50.78^{h}
	B	42.74	47.87	50.45	53.14	56.49	57.66	58.49	52.40^{g}
	C	50.90	56.55	62.45	66.90	68.03	69.84	70.10	63.54^{b}
	D	46.00	52.33	58.98	62.02	63.12	65.24	67.10	59.40^{d}
	E	43.98	48.09	51.12	53.43	56.90	58.09	59.17	52.97^{gf}
	F	44.31	50.80	52.01	55.13	57.24	57.99	59.24	53.82^{ef}
	G	54.36	60.07	64.11	68.95	71.17	72.89	74.22	66.54^{a}
	H	49.98	55.09	60.44	64.08	66.66	68.46	70.19	62.13^{c}
	I	44.66	51.38	53.22	55.89	57.56	58.74	60.17	54.52^{e}
	Means	46.31^{G}	52.23^{F}	55.76^{E}	59.06^{D}	61.32^{C}	62.75^{B}	63.99^{A}	
Syneresis % (after 24h of mixing with water)	A	42.42	50.00	50.11	54.65	57.14	60.12	63.16	54.09^{d}
	B	44.43	51.62	52.30	54.31	57.27	60.14	63.38	55.50^{d}
	C	53.33	61.07	63.19	67.65	69.73	71.25	72.35	65.51^{ab}
	D	48.40	56.67	59.08	63.56	64.02	66.23	68.70	61.03^{c}
	E	44.33	52.05	53.98	55.87	57.96	59.75	70.04	56.23^{d}
	F	47.15	53.25	54.23	56.97	59.41	61.20	64.24	55.92^{d}
	G	56.81	63.88	65.56	69.37	73.05	74.12	75.55	68.33^{a}
	H	50.51	56.88	61.70	65.48	67.13	69.67	71.90	63.32^{cb}

	I	46.94	54.07	54.77	57.05	58.70	60.41	62.13	56.30^{d}
	Means	48.89^{E}	55.55^{D}	56.65^{D}	60.55^{C}	62.71^{CB}	64.77^{AB}	67.99^{A}	

Treatment A: Jameed made from sheep buttermilk (control) with ball form.

Treatment B: Jameed made from goat skim milk with ball form.

Treatment C: Jameed made from goat skim milk with triangle form.

Treatment D: Jameed made from goat skim milk with square form.

Treatment E: Jameed made from goat skim milk with cylinder form.

Treatment F: Jameed made from cow skim milk with ball form.

Treatment G: Jameed made from cow skim milk with triangle form.

Treatment H: Jameed made from cow skim milk with square form.

Treatment I: Jameed made from cow skim milk with cylinder form.

4.7. Changes in Textural Characterizes of Jameed at the End of Storage

The force necessary to attain a given deformation with a maximum force bite when the sample is placed between molars is termed as hardness (Nateghi *et al.*, 2012). Cohesiveness is defined as the extent to which a sample can be deformed before it ruptures (Chen *et al.*, 1978). Gumminess is defined as the energy needed to disintegrate a semisolid food until it becomes ready for swallowing (Nateghi *et al.*, 2012). Chewiness is defined as the number of masticates required for a certain amount of sample in order to satisfactorily decrease the consistency for swallowing (Nateghi *et al.*, 2012).

Results of hardness, cohesiveness, springiness, gumminess and chewiness of jameed at the end of storage period are tabulated in Table 7. The values of textural mentioned properties significantly ($p<0.05$) affected by the type of milk used in jameed production. Utilization of sheep buttermilk yielded jameed with high values of hardness, cohesiveness, gumminess and chewiness and low levels of springiness. This may be due to high total solids content. Cow skim milk jameed recognized to have hardness, cohesiveness, gumminess and chewiness levels higher than those of goat milk jameed while springiness values had the opposite trend. In both goat and cow skim milk jameed, the spherical and cylindrical shapes had the minimum values of hardness, cohesiveness, gumminess and chewiness whereas the triangle and square forms possessed the maximum levels.

Table-7. Textural properties of jameed at the end of storage period

Treatments	Hardness	Cohesiveness	Springiness (mm)	Gumminess (N)	Chewiness (N/mm)
A	(N)	(B/A area)	1.497^{a}	6.846^{ab}	4.573^{b}
B	22.10^{a}	0.309^{a}	0.757^{b}	3.266^{c}	6.410^{ab}
C	14.72^{de}	0.153^{a}	0.553^{b}	7.464^{ab}	7.607^{ab}
D	19.70^{ab}	0.243^{a}	0.637^{b}	5.331^{cab}	7.314^{ab}
E	17.80^{dcb}	0.222^{a}	0.760^{b}	3.270^{c}	6.419^{ab}
F	14.50^{e}	0.155^{a}	0.628^{b}	4.371^{cb}	6.860^{ab}
G	15.66^{dce}	0.172^{a}	0.534^{b}	8.335^{a}	8.052^{a}
H	20.01^{ab}	0.276^{a}	0.625^{b}	6.846^{ab}	7.568^{ab}
I	18.15^{cb}	0.243^{a}	0.630^{b}	4.376^{cb}	6.871^{ab}

Treatment A: Jameed made from sheep buttermilk (control) with ball form.

Treatment B: Jameed made from goat skim milk with ball form.

Treatment C: Jameed made from goat skim milk with triangle form.

Treatment D: Jameed made from goat skim milk with square form.

Treatment E: Jameed made from goat skim milk with cylinder form.

Treatment F: Jameed made from cow skim milk with ball form.

Treatment G: Jameed made from cow skim milk with triangle form.

Treatment H: Jameed made from cow skim milk with square form.

Treatment I: Jameed made from cow skim milk with cylinder form.

4.8. Microstructure of Jameed at the End of Storage Period

Electron microscopic studies offer opportunities for studying the structural characteristics of cheese as they relate to other physicochemical properties (Caric *et al.*, 1985). Supporting of this point of view, Marchesseau *et al.* (1997) stated that microscopy has been employed extensively to study cheese structure to explain the physicochemical changes in dairy products that occur during manufacture and storage. Therefore, scanning electron microscopy (SEM) was used in our study for more deeply understanding of the effect of jameed forms change on the structural properties. The microstructures of jameed samples at the end of storage period are shown in Figure 2.

The protein network for the jameed made from sheep buttermilk (sample A) tended to be qualitatively thicker than the jameed made from goat and cow skim milk (samples B and F respectively). However, the protein matrix was coarser and more granular in treatments B and F than treatment A. The protein matrix of cow skim milk jameed observed with SEM has a relatively denser structure than that of goat skim milk jameed. Also, scanning electron microscopic examination demonstrated that small gaps of different sizes, indicated by the black regions, were embedded in the protein network in both goat and cow skim milk jameed but they were more visible in goat skim milk one. These gaps contained the fat globules. The microscopic images correlated well with textural characteristics reported in Table 7. The hardest jameed (sample A) had less porous and more compact structure. Similar observations were reported by Mistry *et al.* (2006) who showed that in the firmest cheese, a very compact protein network was observed. Soodam *et al.* (2014) found that small gaps appear at the interface between the fat and protein phases by week 13 of ripening period of Cheddar cheese, which could arise from proteolysis of the protein network leading to a weaker structure that behaves differently during microscopy sample preparations. That is, the interface of the protein and fat could be considered as the weakest point within the structure. As such, gaps are more likely to appear in the aged cheese at the fat-protein interface.

Distinct variations were noted between the images of ball, triangle, square and cylinder jameed. As previously mentioned, the ball jameed (samples B and F) characterized with a coarse granular structure with relatively large pores whereas in triangle jameed some compact protein masses with coarse structure contained little spaces were observed. In square and cylinder jameed, protein network possessed rigid plate's structure, little aggregates and more gaps scattered in matrix.

5. CONCLUSION

From chemical, microbial and rheological measurements, jameed with good quality was successfully prepared using triangle, square and cylinder shapes. Utilization of triangle, square and cylinder molds in jameed production not only helps to obtain suitable quality but also reduce the production time. Hydraulic pressure can be applied with these molds. Consequently, moisture expulsion will be faster which decrease the time of solar drying period and minimize jameed contamination and increase shelf life. On the contrary, it is impossible to use hydraulic pressure with spherical shape.

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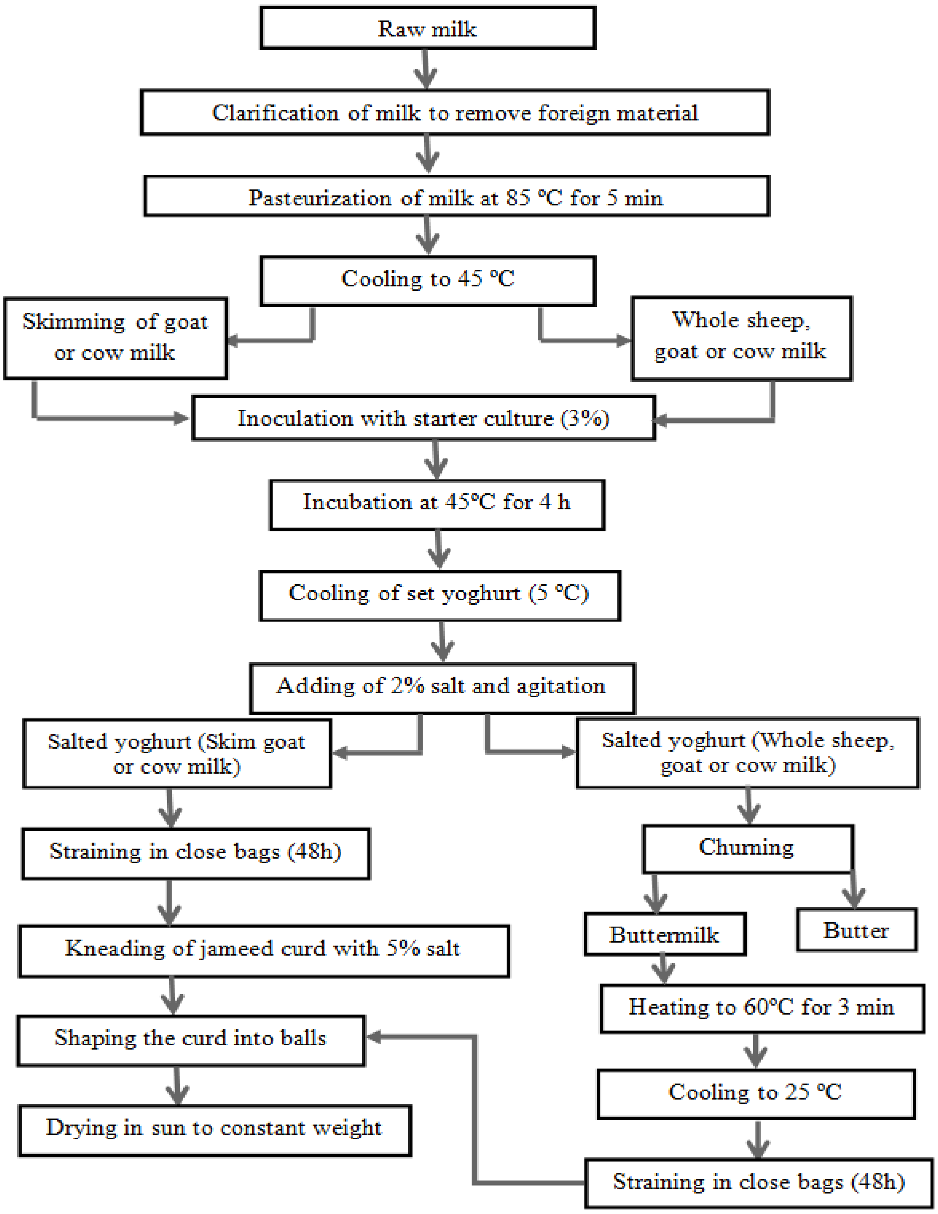

Figure-1. The processing steps for Jameed made from sheep, goat and cow skim or butter milk
Source: Quasem *et al.* (2009)

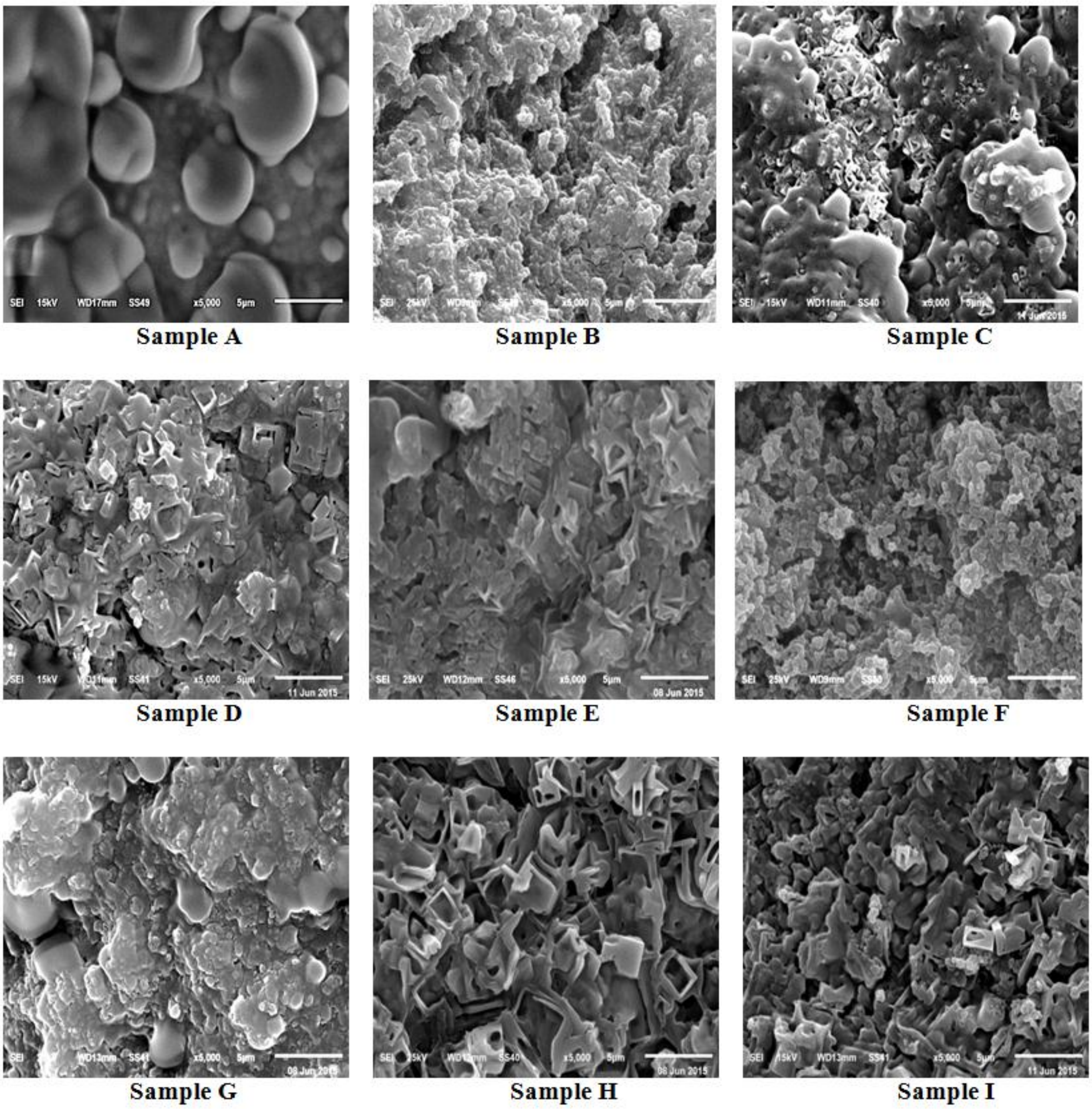

Figure-2. Scanning electron micrographs of jameed at the end of storage period

Treatment A: Jameed made from sheep buttermilk (control) with ball form.

Treatment B: Jameed made from goat skim milk with ball form.

Treatment C: Jameed made from goat skim milk with triangle form.

Treatment D: Jameed made from goat skim milk with square form.

Treatment E: Jameed made from goat skim milk with cylinder form.

Treatment F: Jameed made from cow skim milk with ball form.

Treatment G: Jameed made from cow skim milk with triangle form.

Treatment H: Jameed made from cow skim milk with square form.

Treatment I: Jameed made from cow skim milk with cylinder form