Symbiosis

www.symbiosisonline.org
www.symbiosisonlinepublishing.com

Research Article | Journal of Nutritional Health & Food Science | Open Access

Improvement of Chemical Properties of Jameed by Fortification with Whey Protein

Magdy Mohamed Ismail[1*], Mohamed Nour-Eldin Farid Hamad[2], Reham Kamal El-Menawy[1]

[1]*Dairy Technology Department, Animal Production Research Institute, Agricultural Research Center, Dokki, Giza, Egypt*

[2]*Department of Dairying, Faculty of Agriculture, Damietta University, Damietta, Egypt*

Received: June 22, 2017; Accepted: November 30, 2017; Published: December 12, 2017

***Corresponding author:** Magdy Mohamed Ismail, Dairy Technology Department, Animal Production Research Institute, Agricultural Research Center, Dokki, Giza, Egypt, Tel: +20507231566. E-mail: magdy250@yahoo.com*

Abstract

Background: Jameed is a dried fermented milk food commonly used as a traditional dairy product in several Mediterranean countries including Jordan, Syria, Saudi Arabia, Iraq and Egypt.The aim of this work was to study the effect of blending whey protein paste (a by-product in Ras cheese production) with jameed curd on the chemical composition and microbial properties of the produced jameed.

Materials and Methods: Nine treatments of jameed were made from sheep buttermilk, goat and cow skim milk with adding 10, 15 and 20% whey protein paste to jameed curd. Jameed samples were stored at room temperature for 180 days and chemically and microbiologically analysed every month.The obtained results were statistically analyzed using a software package based on analysis of variance (One-factor analysis of variance, ANOVA, with SPSS software).

Results: The obtained results showed that acidity, total solids, ash, total protein and non-protein-nitrogen values of jameed made from sheep buttermilk were higher than that of jameed prepared from goat or cow skim milk. Mixing whey protein paste with jameed curd increased acidity, total solids, total protein, ash, non-protein- nitrogen, total free amino acids and lactic acid bacteria count. Economic study for utilization of whey protein in jameed production showed that incorporation of 10 and 15% whey protein paste with goat or cow skim milk jameed curd increased the net profit.

Conclusion: To improve the chemical characteristics, to enhance the nutritional values and to increase the profit of jameed manufacture, it is recommended to add 10 or 15% whey protein paste to jameed curd.

Keywords: Jameed; chemical composition; amino acids; economic study; Whey protein paste.

Introduction

Jameed can be defined as a solar dried fermented dairy product. It is made up of sheep or goat's milk and is used in traditional Bedouin cooking of the Mediterranean area including Jordan, Palestine, Syria and Iraq. For example, mansaf is a traditional Jordanian dish that is composed of rice and cooked Jameed [1]. Jameed is characterized by a long shelf life due its low water activity and pH and its low moisture and high salt content. Lactic acid and salt can reduce the growth of pathogenic microorganisms and so Jameed is generally considered as a safe product from the perspective of consumer health [2]. Consumer acceptance of Jameed is influenced mainly by its organoleptic properties that include texture, taste and color appearance [3].

On the other hand, whey protein is a pure, natural, high-quality by-product of the cheese making. It is often characterized as the "Gold Standard" of protein as it is the most nutritious protein available. There are several dairy products which have been made with the inclusion of whey protein products. Isletenand Karagul-Yuceer made yoghurt from reconstituted skim milk powder supplemented with whey protein isolate, whereas Pinto, et al. utilized whey protein concentrate in preparing processed cheese spread. Ismail, et al. mixed whey protein with milk in low-fat Mozzarella manufacture. Ismail, et al. used whey protein in Feta cheese production [4-7]. Recently in Egypt, salted whey resulted from Ras cheese making is used for production whey protein paste.

Although there have not been reports regarding the amino acids content of jameed, also there is no information regarding the impact of adding whey protein to jameed on its physicochemical and nutritional properties. Furthermore, feasibility study for Jameed manufacture was not previously conducted. Thus, the aim of this work was to study the possibility of improvement the chemical and nutritional properties of jameed by mixing with different concentrations of whey protein paste and investigate the effect of this technic on the netprofit of jameed processing.

Materials and methods

Materials

Fresh sheep, goat and cow milk were obtained from Animal Production Research Institute, Agricultural Research Center, Egypt. A commercial classic yoghurt starter containing *Str. thermophilus* and *L. delbrueckii* sub sp. *bulgaricus* (1:1) (Chr. Hansen's Lab A/S Copenhagen, Denmark) was used. All used chemicals were analytical grade.

 ***Corresponding author email:** magdy250@yahoo.com*

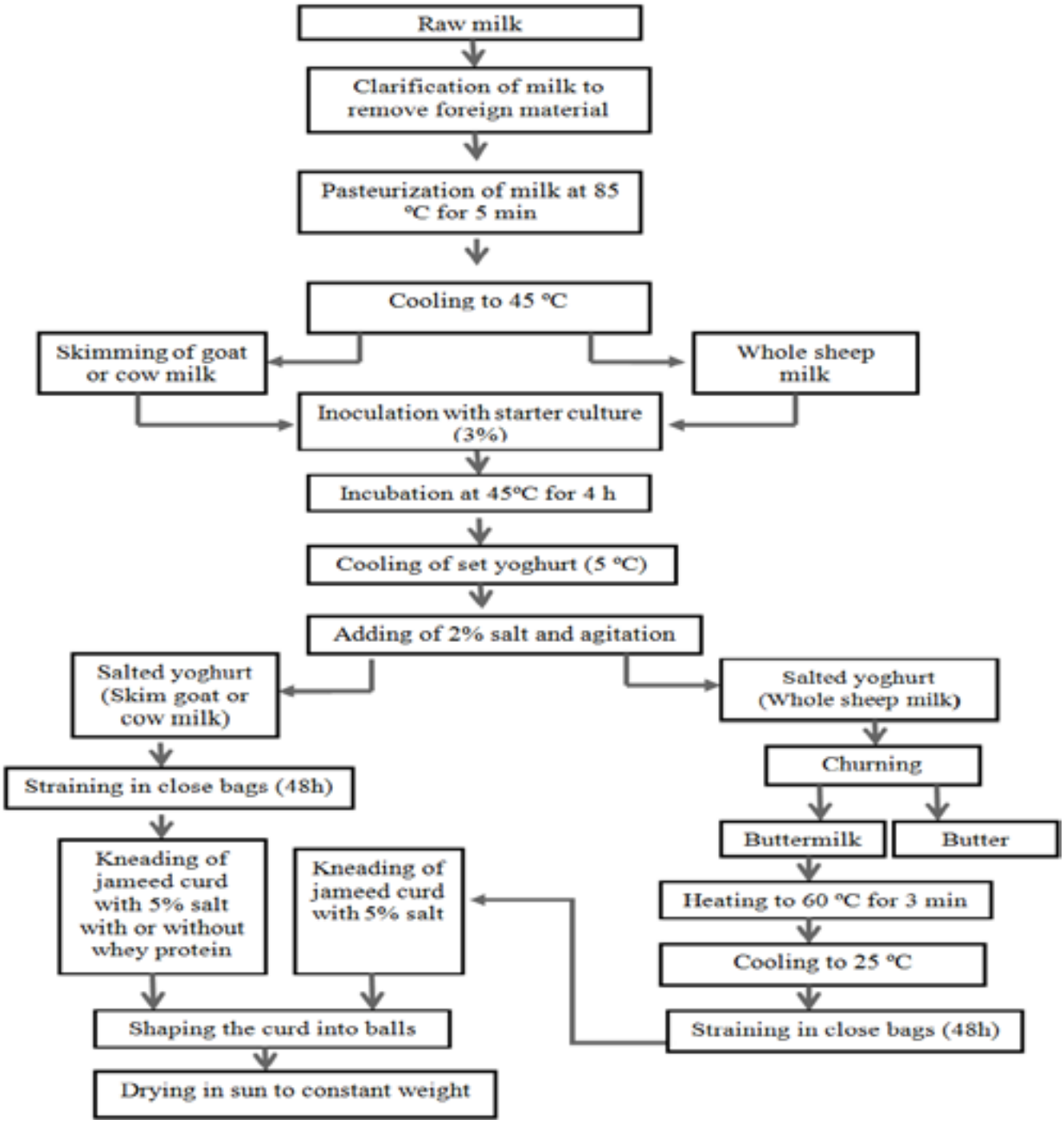

Figure 1: Processing steps for jameed manufacture

Methods

Preparation of Whey Protein

Ras cheese whey was skimmed by milk separator and heated to 95°C for 10 min, cooled and the flocculated denatured whey proteins were obtained by filtering through cheesecloth overnight. The precipitate was transferred to wooden frames and pressed for two hours.

Jameed Manufacture

Nine treatments of jameed were made from sheep buttermilk and from goat and cow skim milk according to the method of Quasem, et al. [8]. Jameed manufacturing was illustrated by Figure 1. After jameed kneading with 5% salt, jameed paste was re-kneaded with whey protein paste and shaped as a ball then dried in sun. Jameed samples were as follow:

- Treatment A: Jameed made from sheep buttermilk (control).
- Treatment B: Jameed made from goat skim milk.
- Treatment C: Jameed made from goat skim milk + 10% (of jameed curd weight) whey protein.
- Treatment D: Jameed made from goat skim milk + 15% (of jameed curd weight) whey protein.
- Treatment E: Jameed made from goat skim milk + 20% (of jameed curd weight) whey protein.
- Treatment F: Jameed made from cow skim milk.
- Treatment G: Jameed made from cow skim milk + 10% (of jameed curd weight) whey protein.
- Treatment H: Jameed made from cow skim milk + 15% (of jameed curd weight) whey protein.
- Treatment I: Jameed made from cow skim milk + 20% (of jameed curd weight) whey protein.

The dried jameed balls were packaged in polyethylene bags and stored at room temperature for 180 days. Samples were analyzed when fresh and after 15, 30, 60, 90, 120, 150 and 180 days of storage period.

Chemical Analysis

Total solids, fat, total nitrogen and ash contents of samples were determined according to AOAC [9].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. 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 of jameed were estimated according to Ling [10]. The Volhard's method as described by Richardson was used to determine the salt content of jameed [11].

Determination of Amino Acids Composition

Amino acid profile of fresh yogurt was performed following the protocol of Walsh and Brown [12]. Hydrochloric acid (6 M) was added to the sample vial for a final concentration of 5 mg of protein/mL of HCl. Hydrolysis vial was placed in an ultrasonic cleaner and flushed with nitrogen gas before sealing under vacuum. Sample was placed in a heating block for 4 hr at 145°C. Afterwards, sample was removed from the heating block and allowed to cool before filtration through 0.2 µm filter. Sample was dried with nitrogen gas and dissolved in a dilution buffer. The prepared sample was analyzed for amino acid profile by running through Automated Amino Acid Analyzer (Model: L-8500 A, Hitachi, Japan). Areas of amino acid standards were used to quantify each amino acid in representative sample.

Microbiological analysis

Jameed samples were analyzed for the 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 [13].

Statistical analysis

The obtained results were statistically analyzed using a software package based on analysis of variance [14]. One way Analysis Of Variance (ANOVA) was carried out with SPSS software (SPSS Inc., Chicago, Illinois, USA). When F-test was significant, least significant difference (LSD) was calculated according to Duncan for the comparison between means [15]. Significance was set at $P < 0.5$. The data presented, in the tables, are the mean of 3 experiments.

Results and discussion

Chemical Composition of Milk and Whey Protein Used In Jameed Manufacture

The physicochemical composition of milk and whey protein used in jameed making was cleared in table 1. Acidity value of sheep buttermilk was higher than goat or cow skim milk. On the contrary, Total Solids (TS) and Solids-Not-Fat (SNF) contents were higher in goat and cow skim milk than that of sheep buttermilk. Fat content of goat skim milk was the highest among milk samples. Sheep buttermilk was richer in protein than goat or cow skim milk.

Whey protein paste characterized with high acidity and low pH values which may be attributed to increasing whey acidity during Ras cheese manufacture. The fat content of whey protein paste was very low which attributed to skimming of Ras cheese whey. Conversely, protein content was high. The addition of salt through Ras cheese production caused rising of salt value in whey protein paste. On a general note, the chemical composition results of whey protein paste detected in our study located in the ranges cleared by Ismail, et al. [6].

Table 1: Chemical composition of milk and whey protein used in jameed manufacture(on moisture basis)

Treatments	Acidity %	pH values	Total solids %	Fat %	Total Protein %	Solids not fat %	Salt %
Sheep buttermilk	0.99[a]	5.92[b]	7.81[c]	0.7[a]	5.10[b]	6.50[b]	-
Goat skim milk	0.16[c]	6.61[a]	9.88[b]	0.9[a]	3.12[c]	8.98[a]	-
Cow skim milk	0.18[c]	6.58[a]	9.40[b]	0.3[b]	3.01[c]	9.10[a]	-
Whey protein	0.35[b]	5.04[c]	27.75[a]	0.8[a]	15.45[a]	-	7.11[a]

[abcde]Letters indicate significant differences between milk treatments. Significance was set at *p <.05*, data are expressed in ±SD

Chemical Composition of Jameed During Storage Period

Sheep buttermilk jameed had higher acidity and lower pH values than jameed made from goat and cow skim milk as shown in table 2. Furthermore, the developments of acidity levels or drop in pH values during storage period were also higher in sheep buttermilk jameed. Cow skim milk jameed contained slightly lower acidity values than goat skim milk jameed.

Using whey protein in jameed made manufacture (treatments C, D, E, G, H and I) increased the acidity values as compared with control (treatments B and F). These results are confirmed with those reported by Tashakori, et al. who found that the control white Feta cheese sample had the lowest acidity and highest pH, and the sample with 1.5% whey protein concentrate had the highest acidity and lowest pH [16, 17]. Supavititpatana, et al. showed that the addition of whey protein isolates enhanced lactic acid production and counts of *Streptococcus thermophilus* and *Lactobacillus bulgaricus.*

During storage period, the acidity in different jameed treatments increased gradually (P<0.05), while pH values significantly decreased (P<0.05). Results in table 2 show fast increase in acidity during the first month of storage followed by slight and gradual increase during the rest of storage period. This might be due to fermentation of lactose to lactic acid.

The highest values of total solids and total protein were found in jameed samples made from sheep buttermilk followed by those made from cow skim milk. Goat skim milk jameed had the lowest total solids and total protein values table 2. Inversely, goat skim milk jameed had the highest fat concentrations while that made from cow skim milk possessed the lowest. Fat contents of sheep buttermilk jameed were at an intermediate position.

Table 2: Effect of mixing whey protein with jameed past on some physicochemical 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	4.31[a]
	B	1.82	2.78	3.27	3.58	3.88	4.07	4.3	4.4	3.45[ab]
	C	2.1	2.85	3.5	3.85	4.18	4.28	4.43	4.52	3.71[ab]
	D	2.18	2.9	3.73	4.08	4.35	4.49	4.65	4.78	3.90[ab]
	E	2.24	3.04	3.88	4.19	4.51	4.65	4.79	4.9	4.06[ab]
	F	1.72	2.6	3.1	3.38	3.62	3.83	3.96	4.08	3.29[b]
	G	2.08	2.68	3.42	3.68	3.93	4.11	4.24	4.36	3.57[ab]
	H	2.12	2.75	3.6	3.85	4.19	4.34	4.51	4.67	3.75[ab]
	I	2.18	2.94	3.77	4.08	4.37	4.5	4.67	4.8	3.91[ab]
	Means	2.05[D]	2.90[CD]	3.60[CD]	3.91[AB]	4.20[AB]	4.36[AB]	4.48[AB]	4.65[A]	
pH values	A	4.98	4.43	4.19	3.91	3.7	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	4.93	4.57	4.4	4.29	4.17	4.11	3.92	3.82	4.21[a]
	D	4.88	4.53	4.33	4.23	4.1	4.03	3.87	3.76	4.15[a]
	E	4.815.41	4.49	4.29	4.18	4.01	3.9	3.8	3.7	4.47[a]
	F	1	4.71	4.49	4.38	4.32	4.23	4.18	4.06	4.34[a]
	G	4.97	4.67	4.42	4.29	4.18	4.13	4.06	4	4.34[a]
	H	4.90	4.63	4.37	4.3	4.14	4.09	3.99	3.9	4.29[a]
	I	4.87	4.56	4.3	4.23	4.1	4.01	3.9	3.82	4.22[a]
	Means	4.93[A]	4.59[AB]	4.37[AB]	4.24[AB]	4.09[AB]	4.01[AB]	3.91[B]	3.82[B]	

Total solids %	A	48.67	82	84.95	86.12	87.08	87.87	88.58	89.06	81.79^{a}
	B	31.89	75.79	78.14	79.1	81.11	82.15	82.21	82.95	73.54^{c}
	C	32.5	75.9	78.34	79.27	81.27	82.3	82.32	83.16	74.38^{bc}
	D	32.8	76.15	78.52	79.42	81.39	82.44	82.41	83.29	74.55^{bc}
	E	33.12	76.34	78.78	79.65	81.6	82.61	82.53	83.46	74.76^{b}
	F	34.14	76.24	79.12	80.26	81.33	82.46	82.97	83.78	75.03^{b}
	G	34.77	76.4	79.27	80.45	81.57	82.59	83.11	83.89	75.26^{b}
	H	34.95	76.57	79.46	80.66	81.74	82.78	83.27	83.97	75.43^{b}
	I	35.19	76.75	79.63	80.84	81.88	82.9	83.42	84.17	75.41^{b}
	Means	35.23^{E}	76.35^{D}	79.58^{C}	80.64^{C}	82.11^{B}	83.07^{AB}	83.42^{A}	84.19^{A}	
Fat %	A	3.85	10.4	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	12.2	12.35	10.90^{a}
	C	4.15	11.32	11.51	11.65	11.8	11.96	12.21	12.3	10.86^{a}
	D	4.1	11.25	11.49	11.61	11.76	11.92	12.18	12.27	10.82^{a}
	E	4.07	11.2	11.45	11.57	11.74	11.89	12.15	12.24	10.79^{a}
	F	3.17	9.9	9.95	10.19	10.31	10.4	10.49	10.6	9.38^{b}
	G	3.12	9.84	9.9	10.17	10.24	10.38	10.46	10.56	9.33^{b}
	H	3.08	9.8	9.88	10.13	10.2	10.33	10.41	10.54	9.17b
	I	3.04	9.77	9.84	10.07	10.18	10.3	10.39	10.5	9.26b
	Means	3.64^{B}	10.54^{A}	10.69^{A}	10.77^{A}	11.01^{A}	11.14^{A}	11.30^{A}	11.41^{A}	
Total protein %	A	29.55	51.13	53.05	53.16	53.31	53.61	53.7	53.81	50.17^{a}
	B	14.95	43.91	47.01	47.34	47.45	47.66	47.78	47.92	43.00^{c}
	C	15.25	44.36	47.3	47.7	47.8	47.94	47.99	48.24	43.32^{c}
	D	15.61	44.75	47.57	45.02	48.17	48.2	48.31	48.56	43.27^{c}
	E	15.94	44.98	47.84	45.29	48.35	48.45	48.64	48.82	43.54^{c}
	F	17.24	47.11	49.23	49.54	49.69	49.87	49.99	50.28	45.37^{b}
	G	17.58	47.37	49.47	49.7	49.97	50.11	50.28	50.6	45.64^{b}
	H	17.96	47.69	48.7	49.95	50.26	50.34	50.52	50.79	45.78^{b}
	I	18.34	47.97	48.97	50.28	50.58	50.67	50.8	50.97	46.14^{b}
	Means	18.05^{E}	46.59^{D}	48.66^{C}	48.85^{BC}	49.51^{ABC}	49.65^{AB}	49.78^{AB}	50.00^{A}	

The data are the mean of 3 experiments. ^{abcde}Letters indicate significant differences between jameed treatments; ^{ABCD}Letters indicate significant differences between storage times; Significance was set at $p < 0.05$

Incorporation of whey protein paste with jameed paste increased total solids and total protein contents in the resultant jameed. In the opposite trend, jameed made from goat or cow skim milk and containing whey protein had slightly lower fat contents compared with control. These results are in line with those reported by Punidadas, et al. but contradicted with those found by Ismail [18, 19]. Punidadas, et al. showed that adding whey proteins improved the yield, but decreased the retention of fat. Homogenization of whey proteins improved fat retention and yield. The dry matter increase was due to increased SNF. Ismail stated that adding whey proteins paste to cow's milk slightly decreased TS and fat contents of Ras cheese [19]. This may due to the high water holding capacity of whey protein which may increase the moisture holding in cheese curd. However, the same author reported that mixing of whey proteins with cheese curd slightly increased TS and fat contents of cheese. This can be explained on the basis that the mechanical treatment of the curd during mixing with whey protein might increase the exudation of the aqueous phase during the cheese processing.

Regardless of milk type or whey protein adding, TS, fat and total protein contents of different jameed samples increased though storage period. The highest rates of increase were noted at the end of sun drying period (after 15 days). Jism stated that the chemical composition of jameed differs because of many factors, including milk production stage, milk sources, animal feeds and processing method [20]. From the viewpoint of quality, moisture content in jameed should not be more than 15% in order to reduce microbial spoilage and to stop any undesirable chemical and physical changes from taking place during storage.

Utilization of sheep buttermilk in jameed production increased ash and salt values levels as compared with those made from goat or cow skim milk table 3. Cow skim milk jameed possessed lower ash contents than jameed made from goat skim milk. The salt contents of goat and cow skim milk jameed were similar. Because whey protein added to jameed contained 7.11% salt, it was normal that the ash and salt values significantly

increased in jameed made from goat or cow skim milk and whey protein mixtures.

As storage period progressed, total protein, ash and salt contents of jameed samples gradually increased which may be due to the continuous loss of the moisture occurring during storage.

Changes in Some Nitrogen Fractions of Jameed

The highest levels of Water Soluble Nitrogen (WSN) and Non-Protein-Nitrogen (NPN) were detected in sheep buttermilk jameed (sample A). Goat skim milk jameed had slightly higher WSN and NPN values than those measured in jameed made from cow skim milk table 3. Increasing total protein and proteolytic bacteria counts in sheep buttermilk jameed may be led to raise these contents.

Just as whey protein addition caused total nitrogen increasing of jameed, also caused increase of WSN and NPN values. The raising levels were more noticeable with NPN contents. These results might be interpreted on the basis of the very high content of NPN in whey protein paste. Generally, during the storage period, the WSN and NPN contents of jameed significantly increased. The increasing levels were higher in treatments contained whey protein than that of other treatments which may be not only related to high amount of nitrogen but also may be due to the stimulation effect of whey proteins on jameed microorganisms. In this sense, Fitzpatrick and O'Keeffe reported that supplementation of whey permeate by whey protein hydrolysate had a beneficial effect on lactose utilization and *Lactobacillus helveticus* growth during fermentation [21].

Table 3: Effect of mixing whey protein with jameed past on some chemical properties

Properties	Treatments	Storage period (days)								Means
		Fresh	15	30	60	90	120	150	180	
Ash %	A	11.5	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	14.6	14.74	13.70^{b}
	C	10.68	13.78	13.97	14.11	14.41	14.6	14.81	14.93	13.91^{b}
	D	10.82	13.88	14.16	14.25	14.58	14.76	14.97	15.14	14.00^{b}
	E	10.97	14.04	14.31	14.47	14.73	14.91	15.21	15.32	14.24^{ab}
	F	9.97	13.3	13.57	13.69	13.94	14.27	14.49	14.64	13.48^{b}
	G	10.21	13.47	13.72	13.82	14.17	14.42	14.63	14.8	13.66^{b}
	H	10.37	13.62	13.86	13.98	14.36	14.59	14.78	14.97	13.82^{b}
	I	10.48	13.76	13.98	14.17	14.54	14.78	14.92	15.19	13.98^{b}
	Means	10.57^{D}	13.81^{C}	14.04^{CB}	$14.20C^{AB}$	$14.51C^{AB}$	14.73^{CAB}	14.94^{AB}	15.04^{A}	
Salt %	A	7.02	10.23	10.58	10.62	10.78	10.87	10.95	11.07	10.27^{a}
	B	6.4	9.72	10.11	10.25	10.39	10.45	10.51	10.57	9.87^{a}
	C	6.57	9.91	10.37	10.38	10.53	10.62	10.66	10.72	9.91^{a}
	D	6.69	10.14	10.53	10.46	10.61	10.75	10.85	10.9	10.12^{a}
	E	6.89	10.29	10.7	10.65	10.74	10.9	10.97	11.04	10.27^{a}
	F	5.88	9.61	9.7	10.07	10.12	10.2	10.33	10.42	9.54^{a}
	G	5.99	9.83	9.89	10.19	10.28	10.37	10.46	10.55	9.63^{a}
	H	6.18	9.97	10.07	10.41	10.39	10.49	10.58	10.64	9.84^{a}
	I	6.37	10.16	10.24	10.6	10.76	10.85	10.92	10.97	10.11^{a}
	Means	6.39^{B}	10.04^{A}	10.24^{A}	10.35^{A}	10.51^{A}	10.61^{A}	10.69^{A}	10.76^{A}	
Water soluble nitrogen %	A	0.468	1.401	1.435	1.463	1.478	1.492	1.51	1.521	1.346^{a}
	B	0.45	1.187	1.194	1.222	1.237	1.245	1.26	1.272	1.133^{a}
	C	0.467	1.207	1.216	1.239	1.256	1.27	1.287	1.297	1.155^{a}
	D	0.481	1.229	1.24	1.267	1.285	1.299	1.321	1.323	1.181^{a}
	E	0.498	1.256	1.269	1.286	1.304	1.327	1.348	1.364	1.207^{a}
	F	0.441	1.159	1.177	1.193	1.206	1.217	1.23	1.242	1.108^{a}
	G	0.455	1.176	1.198	1.216	1.233	1.247	1.265	1.28	1.134^{a}
	H	0.467	1.197	1.225	1.247	1.266	1.282	1.3	1.317	1.163^{a}
	I	0.482	1.221	1.243	1.269	1.29	1.314	1.332	1.351	1.188^{a}
	Means	0.468^{A}	1.225^{A}	1.244^{A}	1.267^{A}	1.284^{A}	1.299^{A}	1.317^{A}	1.329^{A}	

Non-protein-nitrogen %	A	0.089	0.271	0.28	0.29	0.298	0.31	0.317	0.325	0.272^{ab}
	B	0.077	0.25	0.259	0.266	0.261	0.269	0.285	0.293	0.248^{ab}
	C	0.093	0.256	0.28	0.294	0.286	0.298	0.327	0.336	0.276^{ab}
	D	0.109	0.274	0.305	0.317	0.309	0.321	0.359	0.374	0.308^{ab}
	E	0.133	0.295	0.329	0.355	0.332	0.345	0.398	0.401	0.333^{a}
	F	0.078	0.24	0.249	0.256	0.273	0.279	0.273	0.278	0.238^{b}
	G	0.09	0.254	0.267	0.278	0.305	0.318	0.306	0.314	0.262^{ab}
	H	0.107	0.269	0.287	0.299	0.331	0.347	0.33	0.341	0.283^{ab}
	I	0.129	0.287	0.306	0.32	0.369	0.384	0.359	0.372	0.306^{ab}
	Means	0.100^{B}	0.267^{A}	0.285^{A}	0.297^{A}	0.307^{A}	0.319^{A}	0.328^{A}	0.343^{A}	

The data are the mean of 3 experiments. ^{abcde}Letters indicate significant differences between jameed treatments; ^{ABCD}Letters indicate significant differences between storage times; Significance was set at $p < 0.05$

Changes in Amino Acids Contents of Jameed

Sheep buttermilk jameed possessed higher amounts of total, essential, nonessential and branched-chain amino acids as compared with that made from goat skim milk whereas cow skim milk jameed had the lowest table 4. This may be related to the high total protein, WSN and NPN contents of sheep buttermilk jameed. This is consistent with the previous study by Nateghi who showed that NPN values of reduced fat Cheddar cheese parallel increased with increasing of total and free amino acids [22].

The sheep buttermilk jameed, however, was higher in aspartic, glutamic acid, proline, valine, methionine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine, and cysteine but lower in threonine, serine, glycine, alanine and arginine than those of goat skim milk jameed. The majority of amino acids values were higher in goat milk jameed than that made from cow skim milk except for methionine, tyrosine, phenylalanine, and histidine. In contrast, various samples of jameed contained similar values of essential amino acids to total amino acids (E/T).

On the other side, mixing whey protein past with jameed paste greatly increased the total, essential, nonessential and branched-chain amino acids contents. The highest increasing rates of essential amino acids were detected in leucine followed by threonine and valine whereas the lowest was in methionine and histidine. This special character of whey protein jameed increased the priority for human nutrition. The highest increasing levels of nonessential amino acid were in glutamic acid followed by aspartic and lysine while the highest increasing rate of branched-chain amino acids was in leucine content. Studies of and Ha and Zemel reported that whey protein structure is rich in Branched Chained Amino Acid (BCAA) such as leucine, valine, and isoleucine [23]. Whey proteins provide essential amino acids, have the potential to act as a vitamin A precursor and have shown important advantages in the treatment and prevention of diseases [24-26].

In all tested jameed samples, the highest acid content of total free amino acids was that of glutamic acid, which is responsible for protection from cardiovascular diseases, followed by proline. On the contrary, methionine and cystine acids had the lowest contents of total amino acids. The major essential amino acid was leucine followed by valine and phenylalanine. Methionine content was the lowest. Glutamic and proline acids were the predominant of nonessential amino acids. Leucine was the abundant acid of branched-chain amino acids.

Human clinical studies and animal research have demonstrated the health properties of whey proteins, for instance, Chitapanarux, et al. cleared the effectiveness of supplementing whey protein products in the treatment and prevention of liver and metabolic diseases [27].

The Changes in Microbial Counts of Jameed During Storage

It is quite apparent from the results reported in table 5 that the numbers of Total Viable Bacterial Counts (TVBC), lactic acid bacteria and proteolytic bacteria significantly ($P < 0.05$) increased in sheep buttermilk jameed (treatment A) comparing with goat and cow skim milk jameed (treatments B and F respectively). Cow skim milk jameed had the lowest counts of these bacteria among various samples.

On the other hand, incorporation 10, 15 or 20% whey protein paste with jameed increased TVBC, lactic acid bacteria and proteolytic bacteria numbers. This effect was clearer in goat skim milk jameed. As previously mentioned, this may be due to the stimulation influence of whey protein on microbes. This is in close agreement with the report of Ismail et, al. who reported that significantly ($P < 0.001$) increase were observed in TVBC, proteolytic and *bifidobacteria* of analogue Feta cheese as a result of addition whey protein. Akalin, et al. showed that viability of *Streptococcus thermophilus, Lactobacillus delbrueckii ssp. bulgaricus* and *Bifidobacterium animalis* in reduced-fat yoghurt supplemented with 1.5% of whey protein concentrate (WPC) was increased up to 1 log cfu/g after 1 week of storage compared with no supplementation with WPC [7, 28].

During the storage period, the populations of TVBC, lactic acid bacteria and proteolytic bacteria in all jameed treatments significantly ($P < 0.001$) decreased reaching its minimum at the end of storage period. This decrease could be evidently attributed to the increase in titratable acidity and salt levels which control the rate of bacterial growth, or acted as bactericidal agent [29].

Table 4: Effect of mixing whey protein with jameed past on free amino acids content (mg/100g) at the end of storage period

Amino acids	Treatments								
	A	B	C	D	E	F	G	H	I
Aspartic (ASP)	362^{e}	350^{f}	384^{d}	401^{b}	412^{a}	337	365^{e}	382^{d}	395^{c}
Threonine (THR)	193^{f}	201^{e}	227^{c}	239^{b}	250^{a}	190	218^{d}	233^{b}	245^{a}
Serine (SER)	256^{e}	265^{d}	279^{c}	288^{b}	298^{a}	243^{f}	260^{e}	270^{d}	284^{b}
Glutamic acid (GLU)	619^{c}	591	633^{d}	657^{b}	671^{a}	574^{f}	617^{c}	640^{d}	655^{b}
Proline (PRO)	581^{d}	578^{d}	596^{c}	607^{b}	618^{a}	565	583^{d}	594^{c}	605^{b}
Glycine (GLY)	47^{d}	52^{c}	57^{b}	60^{a}	64^{a}	39^{e}	45^{d}	54^{c}	57^{b}
Alanine (ALA)	85^{f}	97^{e}	110^{c}	117^{b}	127^{a}	80^{g}	91^{f}	102^{d}	110^{c}
Valine (VAL)	384^{b}	356^{f}	373^{d}	385^{b}	395^{a}	350	369^{e}	379^{c}	388^{b}
Methionine	41^{a}	19^{e}	27^{c}	33^{b}	36^{b}	25^{d}	31^{b}	40^{a}	44^{a}
Isoleucine (ILE)	210^{b}	191^{e}	203^{c}	209^{b}	215^{a}	180^{f}	198^{d}	201^{c}	209^{b}
Leucine (LEU)	510^{c}	479^{e}	511^{c}	527^{b}	543^{a}	464^{f}	491^{d}	510^{c}	531^{b}
Tyrosine (TYR)	219^{a}	194^{e}	203^{c}	210^{b}	214^{b}	199^{d}	211^{b}	213^{b}	220^{a}
Phenylalanine (PHE)	284^{c}	268^{e}	277^{d}	280^{c}	289^{b}	274^{d}	284^{c}	288^{b}	297^{a}
Histidine (HIS)	75^{c}	70^{d}	76^{c}	81^{b}	84^{b}	71^{d}	78^{c}	84^{b}	89^{a}
Lysine (LYS)	398^{g}	408	436^{e}	452^{c}	471^{a}	390^{h}	423^{f}	441^{d}	459^{b}
Arginine (ARG)	80^{d}	87^{c}	91^{b}	93^{a}	96^{a}	75^{e}	78^{d}	80^{d}	82^{d}
Cystine (CYS)	29^{c}	24^{d}	31^{a}	36^{b}	42^{a}	19	25^{d}	29^{c}	34^{b}
Total amino acids	4374^{f}	4230^{g}	4514^{e}	4675^{c}	4825^{a}	4075^{h}	4367^{f}	4540^{d}	4704^{b}
Total EAA	2095^{f}	1992	2130^{e}	2206^{c}	2283^{a}	1944^{g}	2092^{f}	2176^{d}	2262^{b}
Total Non-EAA	2278^{f}	2238^{g}	2384^{d}	2469^{b}	2542^{a}	2131^{h}	2275^{f}	2364^{e}	2442^{c}
Total BCAA	1104^{c}	1026^{f}	1087^{d}	1121^{b}	1153^{a}	994^{g}	1058^{e}	1090^{d}	1128^{b}
E/T* (%)	47.91^{a}	47.09^{a}	47.19^{a}	47.19^{a}	47.23^{a}	47.70^{a}	47.90^{a}	47.93^{a}	48.09^{a}
Total BCAA/Total (%)	25.24^{a}	25.25^{a}	24.08^{a}	23.98^{b}	23.90^{b}	24.39^{a}	24.23^{a}	24.01^{a}	23.98^{b}

*EAA/Total amino acids; EAA:essential amino acids; Nonessential amino acids: Non-EAA; BCAA: branched-chain amino acids. ^{abcde}Letters indicate significant differences between milk treatments. Significance was set at $p < 0.05$

Table 5: Effect of mixing whey protein with jameed past 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^{f}
	B	58	25	20	15	14	13	9	7	19.94^{h}
	C	69	41	35	28	24	18	14	9	29.75^{e}
	D	82	55	46	39	31	25	20	15	39.13^{c}
	E	97	73	61	53	42	31	23	17	49.63^{a}
	F	50	18	17	15	10	8	6	5	16.13^{i}
	G	61	32	28	23	16	12	9	7	23.50^{g}
	H	73	47	41	33	24	17	13	10	32.25^{d}
	I	86	60	50	42	33	24	18	13	40.75^{b}
	Means	71.28^{A}	42,89^{B}	36.33^{C}	30.00^{D}	23.56^{E}	18.11^{F}	13.89^{G}	10.33^{H}	

Lactic acid bacteria (x 10^3)	A	55	28	21	16	13	10	9	8	20.00^{f}
	B	44	20	15	10	9	8	6	3	14.38^{h}
	C	54	31	25	18	15	11	8	6	21.00^{e}
	D	68	44	35	27	23	17	12	9	29.38^{c}
	E	83	57	46	36	31	24	17	12	38.25^{a}
	F	38	16	13	10	9	5	3	0.6	11.83^{i}
	G	47	24	19	15	12	8	6	4	16.88^{g}
	H	58	34	27	21	16	11	10	7	23.00^{d}
	I	71	47	40	32	24	17	14	10	31.88^{b}
	Means	57.56^{A}	33.44^{B}	26.78^{C}	20.56^{D}	16.89^{E}	12.33^{F}	9.44^{G}	6.62^{H}	
Proteolytic bacteria (x 10^3)	A	6	0.9	0.7	0.3	0.1	0.08	0.05	0.05	1.022^{f}
	B	4	0.6	0.4	0.07	0.06	0.04	0.03	0.01	0.65^{f}
	C	10	6	3	1	0.6	0.4	0.3	0.1	2.67^{d}
	D	16	11	7	4	2	1	0.8	0.6	5.30^{b}
	E	22	15	10	6	4	1	0.9	0.7	7.45^{a}
	F	3	0.2	0.09	0.08	0.05	0.04	0.03	0.01	0.43^{f}
	G	7	4	2	1	0.8	0.5	0.3	0.2	1.97^{e}
	H	12	8	5	3	1	0.9	0.7	0.5	3.88^{c}
	I	18	13	9	6	5	3	1	0.8	6.97^{a}
	Means	10.89^{A}	6.52^{B}	4.13^{C}	2.38^{D}	1.51^{E}	0.77^{F}	0.457^{F}	0.33^{F}	
Moulds & Yeast (x10^3)	A	ND*	ND	ND	ND	0.3	0.4	0.7	0.9	0.28^{cdb}
	B	ND	ND	ND	ND	0.1	0.3	0.6	0.8	0.23^{cd}
	C	ND	ND	ND	ND	0.4	0.5	0.8	1	0.34^{cdb}
	D	ND	ND	ND	ND	0.6	0.5	0.9	2	0.50^{cab}
	E	ND	ND	ND	ND	0.7	0.9	1	3	0.70^{a}
	F	ND	ND	ND	ND	0.09	0.2	0.3	0.5	0.14^{d}
	G	ND	ND	ND	ND	0.3	0.5	0.7	0.9	0.30^{cdb}
	H	ND	ND	ND	ND	0.5	0.7	0.9	1	0.39^{cadb}
	I	ND	ND	ND	ND	0.7	0.9	1	2	0.58^{ab}
	Means	ND	ND	ND	ND	0.41^{C}	$0.54B^{C}$	0.77^{B}	1.34^{A}	

The data are the mean of 3 experiments. ^{abcde}Letters indicate significant differences between jameed treatments; ^{ABCD}Letters indicate significant differences between storage times; Significance was set at $p < 0.05$. *ND: not detected

Concerning moulds and yeasts, they were detected at the ninetieth day of storage in all jameed treatments. Whey protein samples had the highest numbers of moulds and yeasts. Coliform bacteria were not detected over the storage period in various jameed treatments. These findings confirm the hygienic conditions of the manufacture.

Economic Study

The simple economic analysis for utilization of whey protein in jameed manufacture as shown in table 6. The costs of the ingredients used in goat skim milk jameed production without whey protein adding were 366.5 Egyptian L.E. These costs reduced to be 335.75 and 320.4 L.E by adding 10 and 15% whey protein respectively. With equal processing costs in all treatments, the profit of jameed increased by 4.60 and 7.36% for 10 and 15% whey protein samples respectively. Cow skim milk jameed scored higher profit ratios than goat skim milk one. Incorporation of 10 and 15% whey protein paste with cow skim milk jameed curd increased the gains by 5.46 and 8.19% respectively.

Table 6: Economic study of using FWP in jameed production

Ingredients	Treatments																	
	Goat jameed			Goat jameed+ 10% WP			Goat jameed+ 15% WP			Cow jameed			Cow jameed+ 10% WP			Cow jameed+ 15% WP		
	IA*	IP**	TIP**	IA	IP	TIP	IA	IP	TIP	IA	IP	TIP	IA	IP	TIP	IA	IP	TIP
Fresh skim milk (kg)	100	3.5	350	90	3.50	315.0	85	3.50	297.5	100	3.00	300.0	90.33	3.00	271.0	85.50	3.00	256.5

Whey protein paste (kg)	-	-	-	1.915	3.0	5.75	2.872	3.0	8.62	-	-	-	1.617	3.0	4.851	2.425	3.0	7.275
Starter (kg)	3	5	15	2.7	5	13.5	2.55	5	12.75	3	5	15	2.7	5	13.5	2.55	5	12.75
Salt (kg)	3	0.5	1.5	3	0.5	1.5	3	0.5	1.5	3	0.5	1.5	3	0.5	1.5	3	0.5	1.5
Total ingredients price (L.E)	-	-	366.5	-	-	335.75	-	-	320.4	-	-	366.5	-	-	290.85	-	-	278.02
Processing cost (L.E)	30			30			30			30			30			30		
Total production cost (L.E)	396.5			365.75			350.4			346.5			320.851			308.025		
[ingredients + processing]																		
Jameed curd yield kg	19.15			17.235 JC+1.915 WP			16.277 JC+2.872			16.715			15.098 JC+1.617 WP			14.290 JC + 2.425 WP		
Jameed yield kg	7.57			7.51			7.5			6.8			6.8			6.8		
Jameed selling price (L.E/ Kg)	120			120			120			120			120			120		
Total jameed selling price	908.4			901.2			900			816			816			816		
Gain (L.E/100 Kg)	511.9			535.45			549.6			469.5			495.15			507.975		
Gain increasing (L.E)	-			23.55			37.7			-			25.65			38.475		
Gain increasing %	-			4.6			7.36			-			5.46			8.19		

*IA: Ingredient amount (kg); **IP: Ingredient price (L.E/kg); ***TIP: Total ingredient price (L.E)
WP: whey protein; JC: jameed curd

Conclusion

Traditionally, jameed is made from sheep butter milk. The results of this study proved that jameed can be made with good quality from goat or cow skim milk. Adding 10 and 15% whey protein highly improved the chemical composition of jameed. Blending whey protein paste with jameed past increased the total, essential, nonessential and branched-chain amino acids contents. On the other hand, mixing of 10 and 15% whey protein paste with jameed curd increased the gains.

Acknowledgement

This work was supported by the Animal Production Research Institute, Agricultural Research Center Grant (13/5/1-19/5/2013).

Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Alu'datt MH, Rababah T, Alhamad MN, Obaidat MM, Gammoha S, Ereifej K, et al. Evaluation of different drying techniques on the nutritional and biofunctional properties of a traditional fermented sheep milk product. Food Chemistry. 2016;190: 436–441.doi.org/10.1016/j.foodchem.2015.05.118
2. Al Omari A, Quasem JM, Mazahreh AS. Microbiological analysis of solar and freeze-dried jameed produced from cow and sheep milk with the addition of carrageenan mix to the jameed paste. Pakistan J Nut. 2008;7(6): 726-729. doi.org/10.3923/pjn.2008.726.729
3. Nolan-Clark DJ, Neale EP, Probst YC, Charlton KE, Tapsell LT. Consumers' salient beliefs regarding dairy products in the functional food era: A qualitative study using concepts from the theory of planned behavior. BMC Public Health. 2011;11:843. doi.org/10.1186/1471-2458-11-843
4. Isleten M, Karagul-Yuceer Y. Effects of dried dairy ingredients on physical and sensory properties of nonfat yoghurt. J Dairy Sci. 2006;89(8):2865-2872. doi.org/10.3168/jds.s0022-0302(06)72559-0

5. Pinto S, Rathour AK, Prajapati JP, Jana AH, Solanky MJ. Utilization of whey protein concentrates in processed cheese spread. Natural Product Radiance. 2007;6(5):398-401.
6. Ismail MM, Ammar E, El-Metwally R. Improvement of low fat Mozzarella cheese properties using denatured whey protein. Int J Dairy Technol. 2011;64:207-217. doi.org/10.1111/j.1471-0307.2010.00654.x
7. Ismail MM, Ammar EMA, El-ShazlyAK, Eid MZ. The impact of partial replacement of milk protein concentrates by acid whey proteins and adding bifidobacteria on some properties of functional analogue Feta cheese. American J Food Sci and Nut Res. 2015;2:10-20.
8. Quasem JM, Mazahreh AS, AfanehIA, Al Omari A. Solubility of solar dried jameed. Pakistan J Nut. 2009;8(2):134-138. doi.org/10.3923/pjn.2009.134.138
9. AOAC. Official methods of analysis of AOAC International (17th ed.). 2000; Washington, DC, USA: AOAC International.
10. Ling ER. A Text - Book of Dairy Chemistry. Vol. 2, Practical, 3rd ed. 1963;Champan and Hall, London, England.
11. Richardson GH. Standard Methods of the Examination of Dairy Products. (15thed.). 1985; American Public Health Association. Washington, DC.
12. Walsh MK, Brown RJ. Use of amino acid analysis for estimating the individual concentrations of proteins in mixtures. J Chromatogr A. 2000;891(2):355-360. doi.org/10.1016/s0021-9673(00)00649-x
13. American Public Health Association. Standard methods for the examination of dairy products. Amer Publ Health Assoc Inc. (12thed.). 1992;New York, USA.
14. SAS. SAS User's guide: statistics. 1991; SAS Inst, Inc, Cary, NC.
15. Duncan DB. Multiple Rangeand Multiple F-test. Biometrics.1955;11:1-42. doi.org/10.2307/3001478
16. Tashakori A, Yasini-Ardakani SA, Daneshi M. Effect of whey protein concentrate and cornstarch on chemical, rheological and sensorial properties of white Feta cheese. American J Food Sci and Tech. 2013;1:25-29.
17. Supavititpatana P, WirjantoroTI, Raviyan P. Effect of sodium caseinate and whey protein isolate fortification on the physical properties and microstructure of corn milk yoghurt. CMU J Nat Sci. 2009;8:247-263.
18. Punidadas P, FeirtagJ, Tung MA. Incorporating whey proteins into Mozzarella cheese. Int J Dairy Tech. 1999;52:51-52. doi.org/10.1111/j.1471-0307.1999.tb02070.x
19. Ismail MM. Effect of adding denatured whey proteins to cheese milk or cheese curd on some properties of Ras cheese. Egyptian J Dairy Sci. 2012;40:59-66.
20. Jism. Jordanian Institute for Standards and Microbiology, Ammann, Jordan;1997.
21. Fitzpatrick JJ, O Keeffe U. Influence of whey protein hydrolysate addition to whey permeate batch fermentations for producing lactic acid. Process Biochem. 2001;37(2):183-186. doi.org/10.1016/s0032-9592(01)00203-5
22. Nateghi Leila. Effects of different adjunct starter cultures on proteolysis of reduced fat Cheddar cheese during ripening. African J Biotechnol. 2012;11:12491-12499. doi.org/10.5897/ajb11.3359
23. Ha E, Zemel MB. Functional properties of whey, whey components, and essential amino acids: mechanisms underlying health benefits for active people (review). J Nutr Biochem. 2003;14(5):251-258.
24. Pal S, Ellis V. The chronic effects of whey proteins on blood pressure, vascular function, and inflammatory markers in overweight individuals. Obesity. 2010;18(7):1354-1359. doi.org/10.1038/oby.2009.397
25. Pal S, Ellis V, Dhaliwal S. Effects of whey protein isolate on body composition, lipids, insulin and glucose in overweight and obese individuals. Br J Nutr. 2010;104(5):716-723. doi.org/10.1017/s0007114510000991
26. Hamad EM, Taha SH, AbouDawood AG, SitohyMZ, Abdel Hamid M. Protective effect of whey proteins against nonalcoholic fatty liver in rats. Lipids Health Dis. 2011;10:57. doi.org/10.1186/1476-511x-10-57
27. Chitapanarux T, Tienboon P, Pojchamarnwiputh S, Leelarungrayub D. Open-labeled pilot study of cysteine-rich whey protein isolate supplementation for nonalcoholic steatohepatitis patients. J Gastroenterol Hepatol. 2009;24(6):1045-1050. doi.org/10.1111/j.1440-1746.2009.05865.x
28. Akalin AS, Gonc S, UnalG, Fenderya S. Effects of fructooligosaccharide and whey protein concentrate on the viability of starter culture in reduced-fat probiotic yogurt during storage. J Food Sci. 2007;72(7):222-227. doi.org/10.1111/j.1750-3841.2007.00436.x
29. El-Abd MM, Abd El-Fattah AM, Osman SG, Abd El-Kader RS. Effect of some lactic acid bacteria on the properties of low salt Domiati cheese. Egyptian J Dairy Sci. 2003;31:125-138.