International Journal of
Dairy Science

ISSN 1811-9743

Academic
Journals Inc.

www.academicjournals.com

OPEN ACCESS International Journal of Dairy Science

ISSN 1811-9743
DOI: 10.3923/ijds.2016.11.19

Research Article
Evaluation of Healthy Soft Cheese Produced by Buffalo's Milk Fortified with Black Rice Powder

[1]Abdel Satar M. Gabr, [2]Saad A. Mahgoub, [2]Adly S. Abdel Satar and [2]Walid M. Shehata

[1]Department of Dairy Technology Research,
[2]Department of Crop Technology Research, Agriculture Research Center, Food Technology Research Institute, Giza, Egypt

Abstract

In the present study it was possible to use black rice powder as fortified of soft cheese. Black rice powder contained rich amount of antioxidants (anthocyanin's, total phenols and total flavonoids), protein, crude fiber, total carbohydrates and minerals. Soft cheese was made from buffalo's milk using 5, 10 and 15% black rice powder. The soft cheese control and their treatments were stored for 60 days. The results showed that the black rice powder contained total protein, 9.72%, anthocyanin's (4874.8 mg cy-3-glc/100 gm dray weight), total phenols (695.4 mg GAE/100 g dray weight), total flavonoids (112.6 mg quarstine/100 g dray weight) and DPPH (76.85%). Buffalo's milk contained protein 4.25% and fat 6.32%, while milk powder contained protein 28.3% and fat 36.1%. Total protein, fat, pH and salt reduced of soft cheese produce, while crude fiber, ash, total carbohydrates, acidity were increasing. While, anthocyanin's, total phenols, total flavonoids and DPPH were 663.5, 71.3, 19.2 and 12.5, respectively) after 60 days at level 15% black rice powder. Soft cheese yield was increased at level 15% black rice powder to rate 8% compared with control cheese. Synersis was decreased at level adding 15% to 568 mL/1000 g compared with control cheese 600 mL/1000 g. Texture profile analysis parameters (firmness, cohesiveness, gumminess, chewiness and springiness) were decreased, while the resilience parameter was increasing during the storage periods. Total Bacterial Count (TBC) was detectable, during storage periods. Yeast and moulds were not detectable at zero time and detectable in control product, but not detectable in the other treatments during storage periods (20 and 40 days), while yeast and moulds were detectable after storage 60 days of control and their treatments. Sensory evaluation of soft cheese fortified with 5% black rice powder had the highest score of overall acceptability in the different periods of storage. Finally, the study indicated that possibility to produce healthy soft cheese fortified 5% black rice powder.

Key words: Black rice powder, soft cheese, yield cheese, synersis cheese, texture profile analysis, microbiology assay

Received: October 02, 2015 **Accepted:** November 14, 2015 **Published:** December 15, 2015

Citation: Abdel Satar M. Gabr, Saad A. Mahgoub, Adly S. Abdel Satar and Walid M. Shehata, 2016. Evaluation of Healthy Soft Cheese Produced by Buffalo's Milk Fortified with Black Rice Powder. Int. J. Dairy Sci., 11: 11-19.

Corresponding Author: Abdel Satar M. Gabr, Department of Dairy Technology Research, Agriculture Research Center, Food Technology Research Institute, Giza, Egypt

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Functional foods refer to foods or food ingredients that provide specific physiological beneficial effects and/or reduce the risk of chronic disease beyond basic nutritional functions (Da Cruz *et al*., 2009).

Rice is a widely consumed food source for over half of the world's population. There are many different kinds of rice, including white rice and a variety of colored rice. Rice with colored hulls has long been considered to be a health food. Reports have shown that supplementation of diets with black rice pigments markedly reduced atherosclerotic. Black rice pigments are mainly located in the aleurone layer, which is characterized as dark purple to black in color and probably represents a mixture of anthocyanin's (Ling *et al*., 2002).

Black rice is one of the most potential plant sources of dark purple color of anthocyanin pigment. The black rice kernel contains high level of bioactive compounds such as γ-oryzanol, anthocyanin's and phenolic compounds. A number of studies showed that these compounds can reduce low-density lipoprotein cholesterol (LDL), improve lipid profiles, have anti-inflammatory and anti-oxidative activities, may help to fight heart disease and prevent diabetes (Guo *et al*., 2007).

Ramakant (2006) reported that the cheese is a product that made from the curd obtained from milk by coagulating the casein with the help of rennet or similar enzymes in the presence of lactic acid microorganism. Herrington (2000) showed that defined cheese as the fresh or ripened product obtained after coagulation and whey separation of milk, cream or partly skimmed milk, butter milk or a mixture of these products, it can also be made from the milk of cows, sheep, goats and camels or mixture of two of these.

Hassanein *et al*. (2008) reported that the soft cheese fortified 5-10% barley flour gave acceptability quality of flavor, body and texture, appearance and color daring sensory evaluated. Ginger extract fortified cheese gained the highest scores for flavor, texture and overall acceptability in both pickled and un-pickled cheese, which became more acceptable to panelists than control cheese over storage (Abd El-Aziz *et al*., 2012a).

Actual cheese yield is simply expressed as a percent yield (kg cheese/100 kg milk). However, this definition is not completely suitable when, like in this study, evaluating the inconstant composition of fat. Since the fat composition differs, meaning differs with type of fat; the yield should be defined as kg of cheese type per 100 kg milk, with specified content of protein and content and type of fat (IDF., 1991). The determination of the actual yield requires measurement of the weight of inputs and outputs in the production (Fox *et al*., 2000).

Syneresis can be described as the course by which the coagulum is concentrated by the elimination of water and soluble constituents. Syneresis is one of the most important processes in cheese making because it directly affects cheese yield and quality through its effect on moisture, mineral and lactose content of curd. Surprisingly, syneresis is one of the less understood processes in cheese manufacturing. This process can occur spontaneously but it is very limited with enzymatic coagulation. Thus usually two mechanisms are used to promoting syneresis: cutting and stirring (Weber, 1987).

The objectives of this investigation were to produce and evaluate the physicochemical, microbial and sensory properties of soft cheese fortified with black rice powder as a functional dairy food.

MATERIALS AND METHODS

Materials: Black rice grains (*Oryza sativa*) variety obtained from Sakha Station Kaffer El-Sheik, Agricultural Research Center, Giza, Egypt. Buffalo's milk was obtained from Food Technology Research Institute, Agriculture Research Center, Giza, Egypt. Whereas, Starter culture soft cheese (*Streptococcus lactis*) and rennet enzyme were obtained from Chr. Hansen Laboratories, Copenhagen, Danemark. While, fat, salt and skim milk powder were obtained from Giza local market. All other chemicals used were purchased from Algomhorya company, Giza, Egypt.

Methods

Preparation of black rice powder: Grains of black rice were laboratory milled to a fine powder following by grinding into flour and sieving through 40 mesh screens using a hammer mill. The black rice powder was packed in plastic container and kept at refrigerator temperature until used.

Manufacture of soft cheese: The soft cheese manufacture was done according to the method applied by Fahmi and Sharara (1950) with modified by El-Safty *et al.* (1983). Table 1 showed that different mixtures contained of buffaloes' milk 14%, Fat 2%, salt 2%, skim milk powder 17% and black rice powder at different ratios (5, 10 and 15%) were used during manufacture to soft cheese contained total solid 35%.

Table 1: Total solids content of soft cheese and other treatments

		Soft cheese		
		Black rice powder (%)		
Materials	Control	5	10	15
Black rice flour	0.00	5.00	10.00	15.00
Fat content	2.00	2.00	2.00	2.00
Buffaloes' milk	14.00	14.00	14.00	14.00
Skim milk powder	17.00	12.00	7.00	2.00
Salt	2.00	2.00	2.00	2.00
Total	35.00	35.00	35.00	35.00

The different mixtures were heated to 63°C for 30 min and then cold to 45°C, after that, salt 2%, starter culture (*Streptococcus lactis*) 2%, rennet enzyme 3 g/100 kg mixture were added to the different mixtures at pH 6.2±0.2. After that the mixtures were poured in cubs and incubated to complete coagulation at 45°C for 3 h and stored at in refrigerator.

Chemical analysis: Proximate analysis of soft cheese including, moisture, total protein, fat, ash, crude fiber, total solids, acidity and salt were determined according to the methods described by AOAC (2005). Total carbohydrates were calculated by difference, PH value was measured using Jenway pH meter (J-enway Limited, Gransmore green Felsted, Dunmow, England). Total anthocyanin's pigments content of the rice samples was determined, according to the modified pH differential methods of Giusti and Wrolstad (2005) and Hosseinian *et al*. (2008). Total phenols were estimated by the Folin-Ciocalteu method reported by Elfalleh *et al*. (2009). The amount of total flavonoids was according to the method of Nasri *et al*. (2011). The DPPH (2,2 diphenyl-1- picric hydrazyl) radical scavenging activity of methanolic extracts was determined according to the method reported by Okonogi *et al*. (2007).

Soft cheese synersis: Synersis of soft cheese determined according to the method of Farooq and Haque (1992).

Soft cheese yield : Actual cheese yield determined according to the method of Fox *et al*. (2000).

Texture profile analysis: Soft cheese texture measurements were carried out with universal testing machine (Cometech, B type, Taiwan). Provided with software. Back extrusion cell with 25 mm diameter compression disc was used. Two cycles were applied, at a constant crosshead velocity of 1 mm sec^{-1}, to 25% of sample depth and then returned. From the resulting force- time curve, the values for texture attributes, i.e., firmness (N), gumminess (N), chewiness (N), cohesiveness, springiness and resilience were calculated from the TPA graphic (Bourne, 2003).

Microbiological analysis of soft cheese: Sample, were taken periodically after zero time, 20, 40 and 60 days. The samples analyzed microbiologically for total bacterial count, yeast and moulds as described by APHA (1978).

Sensory evaluation: The sensory characteristics of the cheese samples were trained panelists for color, flavor, texture, taste, saltiness and overall acceptability by using sensory evaluation sheet according to Larmond (1987).

Statistical analysis: Statistical analysis was carried out according to Fisher (1970). LSD (Least significant difference) test was used to compare the significant differences between means of treatments (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

In this study, it was observed that nutritional value of raw materials chemical composition of buffalo's milk characterized by high moisture content 84.2% followed by black rice 9.45% and the lowest value of moisture was found in skimmed milk powder 2.45% these result agreed with Thomas *et al*. (2013) who recorded to vary between 10.9-12.6 g/100 g in the black rice powder. Minh (2014) reported that the moisture of black rice powder was 11.7%, protein 8.9%, lipid 3.3%, dietary fiber 75.5% and anthocyanin's 0.49%.

This skimmed milk powder had the highest content of protein 28.3% and the lowest value was found in buffalo's milk 4.25%. Fat content has played a great role in dairy products. The results reveled that skimmed milk powder had the highest level of fat 36.1% and the lowest value was found in black rice 2.13%. Crude fiber recorded 3.25% in black rice but buffalo's milk, skimmed milk free from crude fibers. Abd El-Aziz *et al*. (2012b) reported that buffalo's milk was contained total solids, fat, protein, lactose and ash (17.5, 6.83, 4.34, 4.93 and 0.81%, respectively) and pH value was 6.76.

Skimmed milk powder recorded the highest value of ash 5.63% but the lowest value was found in buffalo's milk 0.83%. Total carbohydrates results also indicate of that the highest value of total carbohydrate found in black rice powder 73.8% and the lowest value was found in buffalo's milk 4.42%. Eckles (2001) reported that the skimmed milk powder contains protein 27%, fat 36% and ash 5%.

Data in Table 2 indicated that the black rice powder contained anthocyanin's, total phenol and total flavonoids (4874.8 mg cy-3-glc/100 g dw, 695.4 mg GAE/100 g dw, 112.6 mg quarstine/100 g dw, respectively) and DPPH was 76.85% but these compounds did not in buffalo's milk and skimmed milk powder. Park *et al.* (2008) reported that total anthocyanin's content in the black rice was (1214.85 mg cy-3-glc/100 g dw). Sompong *et al.* (2011) who reported that total phenol in black rice powder (665.2 665.2 mg GAE/ 100 g dw). Saenkod *et al.* (2013) who found that total flavonoids in black rice powder was (58.47 mg quarstine/100 g dw), while DPPH was 70.52%.

The chemical composition of soft cheese and treatments using buffalo's milk fortified with levels of black rice powder during storage periods 60 days. The results revealed that, the moisture of fresh soft cheese at different level of addition 5, 10 and 15% of black rice powder at zero time ranged from 64.3- 64.9%. While the moisture in the end of the storage 60 days increased 64.9-67.2%. The illustrated results showed that control contained the highest value 15.2% and the lowest value was 12.4% found in total protein of level 15% black rice powder. This results agreement with Abd El-Aziz *et al.* (2012a).

It is relatively no changes between zero time which recorded the highest value of fat was found in control cheese12.5% and the lowest value 8.26% at level of 15% and the end of storage period 60 days slightly decreased. These results agreed with Hefnawy *et al.* (1984). Crude fiber results of cheese control without black rice not found fortified with black rice to 15% increased the crude fiber content from 0.16- 0.68%. On the other hand, end of storage period cheese fortified with 15% black rice record slightly increased in fiber content 0.56%.

The results in Table 3 indicated that the ash content of cheese control was increased slightly. From the data at the same table the ash content ranged from treatment 1.15- 1.46% at zero time, while as ranged from 1.14-1.63% after 60 days of storage. This increase due to fortified cheese with black rice powder. Rinaldoni *et al.* (2014) reported that the soft cheese contained ash ranged from 1.45-1.80%.

On the other hand, the highest content total carbohydrate12.5% was found in cheese with 15% black rice powder at zero time. While at the end of storage slightly increase of carbohydrate were occurred and recorded 7.96, 8.96, 10.7 and 11.8% for control, 5, 10 and 15%, respectively. From the results, it could be noticed the increased of total carbohydrates in soft cheese and their treatments due to the increase amount of black rice powder fortified. These results are agreement with Osman *et al.* (2000).

Table 2: Nutritional value of raw materials

		Raw materials	
Parameters	Black rice	Buffaloes powder	Skimmed milk powder
Moisture (%)	9.45	84.20	2.54
Total protein (%)	9.72	4.25	28.30
Fat (%)	2.13	6.32	36.10
Crude fiber (%)	3.25	-	-
Ash (%)	1.65	0.83	5.63
Total carbohydrates (%)	73.8	4.42	27.40
Total solids (%)	90.5	15.80	97.60
Acidity (as lactic acid)	-	0.15	-
pH	-	6.75	-
Anthocyanin's	4874.8	-	-
Total phenols	695.4	-	-
Total flavonoids	112.6	-	-
DPPH (%)	76.85	-	-

DPPH: 2, 2 diphenyl-1-picric hydrazyl

Table 3: Nutritional value of soft cheese fortified with black rice powder

	Storage periods							
	Zero time				60 Days			
Parameters	Control	5%	10%	15%	Control	5%	10%	15%
Moisture (%)	64.90^{a}	64.60^{a}	64.40^{a}	64.30^{a}	64.90^{b}	65.20^{c}	66.30^{a}	67.20^{a}
Total protein (%)	15.20^{a}	14.30^{b}	13.40^{c}	12.20^{d}	14.30^{a}	13.90^{b}	13.60^{c}	12.90^{d}
Fat (%)	12.50^{a}	11.10^{b}	9.26^{c}	8.26^{d}	11.80^{a}	10.90^{b}	9.12^{c}	8.27^{d}
Crude fiber (%)	00.00^{d}	0.16^{c}	0.39^{b}	0.68^{a}	00.00^{d}	0.31^{c}	0.37^{b}	0.56^{a}
Ash (%)	1.15^{b}	1.25^{b}	1.35^{b}	1.46^{a}	1.14^{c}	1.33^{c}	1.39^{b}	1.63^{a}
Total carbohydrates (%)	6.25^{d}	8.39^{c}	10.90^{b}	12.50^{a}	7.96^{d}	8.96^{c}	10.70^{a}	11.80^{a}
Total solids (%)	35.10^{a}	35.20^{a}	35.20^{a}	35.10^{a}	35.10^{a}	35.20^{a}	35.10^{a}	35.10^{a}
Acidity (as lactic acid)	0.57^{a}	0.59^{a}	0.61^{a}	0.63^{a}	0.63^{c}	0.64^{b}	0.65^{b}	0.67^{a}
pH	5.32^{a}	4.94^{b}	4.82^{c}	4.74^{d}	4.83^{a}	4.55^{b}	4.48^{c}	4.41^{d}
Salt/moisture (%)	3.11^{a}	3.08^{b}	3.06^{c}	3.04^{d}	3.49^{a}	3.46^{b}	3.41^{c}	3.35^{d}
Anthocyanin's	00.00^{d}	243.70^{c}	477.50^{b}	711.20^{a}	00.00^{d}	219.40^{c}	436.10^{b}	663.50^{a}
Total phenols	00.00^{d}	30.60^{c}	65.30^{b}	88.40^{a}	00.00^{d}	23.80^{c}	49.80^{b}	71.30^{a}
Total flavonoids	00.00^{d}	9.77^{c}	21.50^{b}	26.30^{a}	00.00^{d}	6.57^{c}	14.60^{b}	19.20^{a}
DPPH (%)	00.00^{d}	4.84^{c}	8.68^{b}	15.70^{a}	00.00^{d}	3.79^{c}	6.75^{b}	12.50^{a}

Means within a column with different letters are significantly different at $p \leq 0.05$, DPPH: 2, 2 diphenyl-1-picric hydrazyl

The results in Table 3 revealed that, the total solids of control soft cheese was no significantly ($p<0.05$). From the obtained results, it could be noticed that the total solid ranged from 35.1-35.2%. The results agreement with Abd El-Aziz *et al.* (2012a) reported that the total solids in soft cheese 34.1% after 6 week of the storage.

Data in Table 3 indicated that small changes of pH found in zero time and the results ranged from 4.74-5.32 at level 15% black rice powder and control, respectively. At storage period 60 days slight increase occurred in pH ranged from 4.41-4.83 at level 15% black rice powder and control respectively. These results agreed with Ghadge *et al.* (2008). The presented data reveled also, the acidity (as lactic acid) was slightly increased between first day and 60 days. The trend of the change in pH values of all treatments was opposite to the acidity which may be led to more lactic acid production as a result of microorganism's metabolism (Abd-Alla *et al.*, 1993).

The results of salt content in soft cheese in control and other treatments were found in Table 3. From the results, it could be notice that control cheese and its treatments have slightly decreased in salt percent when black rice powder increased. This may be due to the higher moisture content of fortified cheese and/or the effect scattering salt throughout ladling according to Fayed (1982). The results at the same table showed that the salt/moisture percentage recorded the highest value of control cheese 3.11%, but the lowest value was found in level 15% addition was 3.04% at zero time. While after storage period 60 days slightly increase also found to 3.49% in cheese control and 3.35% in cheese fortified with 15% of black rice powder.

The results in Table 3 revealed that anthocyanin's of soft cheese with black rice powder levels 5, 10 and 15% were 243.7, 477.5 and 711.2 (mg cy-3-glc/100 g dw), respectively. On the other hand, the anthocyanin's of soft cheese were slightly decrease after storage period 60 days. Data at the same table cleared that total phenols, total flavonoids and DPPH were slightly decreased after the storage 60 days. Total phenols, total flavonoids and DPPH were recorded reduction 7, 9 and 20.3%, respectively at the end of storage period.

Cheese yield is defined as the amount of cheese expressed in kilograms obtained from 100 kg of milk. It is very important parameters: The higher the recovered percentage solids the greater is the amount of cheese obtained and therefore again in economic terms. It is therefore obvious how to elaborate a rapid method that allows for an estimate before transformation of the final cheese yield on the basis of the composition according with Emmons (1993).

Cheese yield is affected by many factors including milk composition, amount and genetic variants of casein, milk quality, somatic cell count in milk, milk pasteurization, coagulant type, vat design, curd firmness at cutting, and manufacturing parameters according with Fenelon and Guinee (1999).

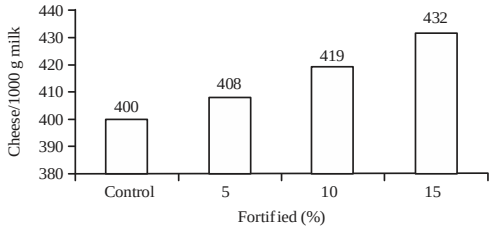

Fig. 1: Cheese yield of fortified with black rice powder

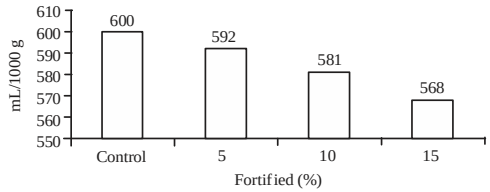

Fig. 2: Synersis of fortified with black rice powder

The results in Fig. 1 clearing that different level of addition increased the cheese yield and the highest quantity of cheese yield found in black rice powder at level 15% compared with control which recorded the lowest quantity of cheese yield, due to the black rice powder contained large amount of the starch and fiber were maintained absorbed water.

The rate and extent of syneresis depend on a number of factors including coagulation conditions, the resulting gel properties, and cutting/stirring conditions (Fagan *et al.*, 2007). Syneresis is considered to be one of the most important steps in cheese making as a result of its effect on moisture, mineral and lactose content of curd. Syneresis control influences cheese homogeneity, quality and yield and also has an impact on protein and fat losses in whey. In essence, the flow of whey must be controlled during cheese manufacturing to minimize losses of solids in whey and to obtain the desired cheese moisture content in order to decrease the production of downgraded cheese. Thus better control of the syneresis process would result in an improvement of the homogeneity and quality of dairy products (Walstra, 1993).

The results in Fig. 2 indicate that the synersis was decreased at the level of 15% to 568 (mL/100 g) compared with control cheese 600 (mL/1000 g), due to added black rice powder because at the end of storage period the water was lost.

Texture analysis is primarily concerned with measurement of the mechanical properties of products, often a food

Table 4: Texture profile analysis of soft cheese fortified with black rice powder

	Storage periods							
	Zero time				20 Days			
Parameters	Cont.	5%	10%	15%	Cont.	5%	10%	15%
Firmness (N)	6.67^{a}	5.81^{b}	4.51^{c}	3.45^{d}	7.06^{a}	6.19^{b}	4.62^{c}	3.61^{d}
Cohesiveness	0.58^{a}	0.47^{b}	0.38^{c}	0.32^{d}	0.77^{a}	0.62^{b}	0.49^{c}	0.37^{d}
Gumminess (N)	3.86^{a}	2.31^{b}	2.21^{c}	0.79^{d}	4.41^{a}	3.01^{b}	2.46^{c}	0.96^{d}
Chewiness (N)	3.38^{a}	2.99^{b}	1.18^{c}	0.64^{d}	4.08^{a}	3.44^{b}	2.63^{c}	0.78^{d}
Springiness	0.88^{a}	0.84^{b}	0.75^{c}	0.71^{d}	0.94^{a}	0.89^{b}	0.78^{c}	0.75^{d}
Resilience	0.58^{d}	0.67^{c}	0.74^{b}	0.85^{a}	0.67^{d}	0.82^{c}	0.85^{b}	0.96^{a}
	Storage periods							
	40 Days				60 Days			
Parameters	Control	5%	10%	15%	Control	5%	10%	15%
Firmness (N)	7.65^{a}	6.79^{b}	5.12^{c}	3.98^{d}	7.95^{a}	7.13^{b}	5.79^{c}	4.56^{d}
Cohesiveness	0.87^{a}	0.74^{b}	0.58^{c}	0.42^{d}	0.96^{a}	0.81^{b}	0.65^{c}	0.51^{d}
Gumminess (N)	4.92^{a}	3.45^{b}	2.89^{c}	1.12^{d}	5.36^{a}	4.05^{b}	3.34^{c}	1.42^{d}
Chewiness (N)	4.51^{a}	3.86^{b}	3.07^{c}	0.93^{d}	5.16^{a}	4.62^{b}	3.43^{c}	1.23^{d}
Springiness	1.02^{a}	0.93^{b}	0.85^{c}	0.79^{d}	1.24^{a}	1.04^{b}	0.97^{c}	0.85^{d}
Resilience	0.78^{d}	0.87^{c}	0.96^{b}	1.03^{a}	0.87^{d}	0.96^{c}	1.06^{b}	1.12^{a}

N: Newton, Means within a column with different letters are significantly different at $p \leq 0.05$

product, as they relate to its sensory properties detected by humans via applying controlled forces to the product and recording its response in the form of force, deformation and time. Texture measurements can be very valuable for the quality control and process optimization as well as for the development of new products with desirable properties and characteristics. These can be divided into the primary parameters of firmness, cohesiveness, springiness and adhesiveness, the secondary parameters of factorability, chewiness and gumminess (Bourne, 1978).

Table 4 showed that texture profile analysis of black rice fortified soft cheese (firmness, cohesiveness, gumminess, chewiness, springiness and resilience) during storage periods. From the results it could be observed that all texture profile cheese with different levels of black rice powder parameters decreased at zero time compared with other treatments. Firmness of black rice powder fortified soft cheese was decreased after zero time, 20, 40 and 60 days storage periods at 5, 10 and 15% compared to control soft cheese. Firmness value was 6.67 in control, while at 15% level was 3.45 at zero time. On the other hand, the firmness was increase after storage 60 days to 4.56 levels 15% black rice fortified cheese compared with 7.95 in control cheese.

Cohesiveness quantifies the internal resistance of food structure. Briefly, cohesiveness is the ability of a material to stick itself. Gumminess is the product of Firmness and cohesiveness. Chewiness represents the amount of energy needed to disintegrate a food for swallowing according to Gomez *et al.* (2007).

Table 5: Microbiological analysis of soft cheese fortified with black rice powder

	Period storage			
Parameters	Zero time	20 Day	40 Day	60 Day
Total bacterial count				
Control	4.51	5.24	5.94	6.78
5%	ND	ND	3.97	5.57
10%	ND	ND	3.21	5.21
15%	ND	ND	ND	4.55
Yeast and moulds				
Control	ND	3.54	5.26	8.92
5%	ND	ND	3.81	4.35
10%	ND	ND	ND	3.74
15%	ND	ND	ND	2.63

ND: Not detected

Cohesiveness of soft cheese was decreased at zero time and 60 days to 0.32 and 4.56 at level 15% black rice powder. Gumminess also recorded the highest value in control cheese 3.86 these cheese slightly increased in the different storage periods reached to 5.36 at the end of storage. Chewiness also recorded slightly increase at the first of storage periods (during zero time, 20, 40 and 60 days).

Springiness measures elasticity by determining the extent of recovery between the first and second compression. Resilience is the ratio of recoverable energy as the first compression is relieved (Lu *et al.*, 2010). Springiness showed increased in control graduals in the periods (0.88, 0.94, 1.02 and 1.24) zero time, 20, 40 and 60 days respectively. Resilience increased slightly in the different periods of storage and there are no significant differences in the different periods.

Results presented in Table 5 showed that an increased in Total Bacterial Count (TBC). In soft cheese of the four

Table 6: Sensory evaluation of soft cheese fortified with black rice powder

	Storage periods							
	Zero time				20 Days			
Parameters	Cont.	5%	10%	15%	Cont.	5%	10%	15%
Color	9.17^{a}	9.53^{a}	8.14^{b}	7.91^{b}	8.66^{a}	9.12^{a}	7.52^{b}	7.33^{b}
Flavor	9.34^{a}	9.56^{a}	8.63^{b}	7.74^{c}	9.56^{a}	9.68^{a}	8.85^{b}	7.81^{c}
Texture	8.52^{b}	9.83^{a}	9.67^{a}	9.54^{a}	8.86^{b}	9.67^{a}	9.52^{a}	9.17^{b}
Taste	9.53^{a}	9.17^{ab}	8.83^{b}	8.19^{b}	9.31^{a}	9.12^{a}	8.91^{a}	7.69^{b}
Saltiness	9.52^{a}	9.33^{a}	9.16^{a}	9.12^{a}	9.67^{a}	9.51^{a}	9.16^{a}	8.89^{a}
O.A.	46.8	47.4	44.4	42.5	46.6	47.1	43.9	40.8
	Storage periods							
	40 Days				60 Days			
Parameters	Cont.	5%	10%	15%	Cont.	5%	10%	15%
Color	8.51^{a}	8.83^{a}	7.34^{b}	7.16^{b}	8.16^{a}	8.63^{a}	7.28^{b}	6.74^{b}
Flavor	9.45^{a}	9.73^{a}	8.72^{b}	7.82^{b}	9.72^{a}	9.75^{a}	8.91^{a}	7.97^{b}
Texture	8.82^{b}	9.55^{a}	9.41^{a}	9.07^{a}	8.65^{a}	9.42^{a}	9.34^{a}	9.13^{a}
Taste	9.66^{a}	9.25^{a}	9.18^{a}	9.19^{b}	9.64^{a}	9.12^{a}	9.16^{a}	8.32^{b}
Saltiness	9.32^{a}	9.23^{a}	9.17^{a}	9.11^{a}	9.15^{a}	9.33^{a}	9.12^{a}	9.02^{a}
O.A.	45.7	46.6	43.8	42.4	45.3	46.3	43.8	41.8

O.A: acceptability. Means within a column with different letters are significantly different at ($p \leq 0.05$)

manufacture trials at refrigerate storage. The Total Bacterial Count (TBC) in all manufactured trials slightly increased until 60 days kept refrigerated storage. The increase can be explained by the sufficient change in the environmental conditions which happen during cheese storage and allow the growth and multiplication of microorganisms.

The same table shows results of yeast and moulds content of manufacture cheese. Results indicated that fresh not detectable but after 20 days started to appears ranged 3.54 and increased slightly up to periods 60 days recorded 8.92 of control cheese. These followed by decrease in the other type of soft cheese recorded 4.35, 3.74 and 2.63 for 5, 10 and 15% of the level of black rice powder respectively. From the data in Table 5 discussion of the black rice powder effect on mechanism of microbial life cycle and alters gross and microbial activity due to high antioxidant content. Matejic *et al*. (2012) reported that the total phenolic content, concentrations of flavonoids and *in vitro* antioxidant and antimicrobial activity.

Data illustrated in Table 6 sensory evaluation of soft cheese at zero time and during the storage period. Total color score decreased by increased the storage period. Soft cheese at level 5% addition black rice powder had the highest score. The flavor of all suggest levels of different levels of addition was improved during storage periods and soft cheese at level 5% had the highest total score compared with another type generally this may be due to the natural flora initially present in raw milk which participate in flavor production.

The texture of control recorded the lowest score at zero time and different periods of storage and level 5% addition black rice powder recorded the highest score at the same condition and factors followed by 10 and, 15% these may due to proteolysis is the most important process happens during cheese storage. It contributes to cheese off flavor, off odor an abnormal texture through the breakdown of the released proteoltic products as amino acid and peptides into amines and acids. Taste of control cheese recorded the highest score of taste compared with different treatments and slithers increased during storage period. Data showed also increased in taste by increasing of storage.

On the other hand the level of addition 15% had the lowest score of taste. Saltiness; the obtained data also indicated that control saltiness decreased by increasing of storage period. Control had the highest score 9.52 at fresh sample these score decreased graduals. Level of addition 15% black rice powder had the lowest and decreased graduals. These may be due to high content of starch. These results agreed with Abd El-Aziz *et al*. (2012a).

Overall acceptability of cheese manufactured with 5% of black rice powder had the highest score of Overall acceptability at the difference periods of storage while soft cheese manufactured at level 15% had the lowest score.

CONCLUSION

From the obviously results, it could be concluded that, the black rice powder was highest of protein, fat, crude fiber, total carbohydrates, antioxidants (anthocyanin's, total phenols,

total flavonoids). Soft cheese produced from buffalo's milk with 5% black rice powder. Soft cheese was high nutritional value; prolong shelf life, overall acceptability received of the arbitration. Therefore, it could be recommended that black rice powder fortified soft cheese with 5% can be applied for production of soft cheese.

ACKNOWLEDGMENTS

Authors would like to thank the Food Technology Research Institute, Agricultural Research Center for ongoing cooperation to support research and that provided facilities necessary to achieve the desired goals of research.

REFERENCES

AOAC., 2005. Official Methods of Analysis of Association of Official Analytical Chemists. 5th Edn., Association of Official Analytical Chemists, Washington, DC., USA.

APHA., 1978. Standard Methods for the Examination of Dairy Products. 14th Edn., American Public Health Association, Washington, DC., USA.

Abd El-Aziz, M.A., S.M. Kholif and T.A. Morsy, 2012a. Buffalo's milk composition and its fat properties as affected by feeding diet supplemented with flaxseed or fibrolytic enzymes in early lactation. J. Life Sci., 4: 19-25.

Abd El-Aziz, M., S.H.S. Mohamed and F.L. Seleet, 2012b. Production and evaluation of soft cheese fortified with ginger extract as a functional dairy food. Pol. J. Food Nutr. Sci., 62: 77-83.

Abd-Alla, E.A.M., H.M. Abbas, N.H. El-Sayed and N.F. Tawfik, 1993. Effect of substitution of soy milk on some chemical properties, formation of biogenic amines and pr-toxin of blue veined cheese. J. Agric. Sci. Mansoura Univ., 18: 2002-2010.

Bourne , M.C., 1978. Texture profile analysis. Food Technol., 32: 62-66.

Bourne, M.C., 2003. Food Texture and Viscosity: Concept and Measurement. Elsevier Press, New York, London.

Da Cruz, A.G., F.C.A. Buriti, C.H.B. de Souza, J.A.F. Faria and S.M.I. Saad, 2009. Probiotic cheese: Health benefits, technological and stability aspects. Trends Food Sci. Technol., 20: 344-354.

Eckles, C.H., 2001. Milk and Milk Products: Technology, Chemistry and Microbiology. 4th Edn., Tata McGraw-Hill Publishing, New Dalhi.

El-Safty, M.S., A.A. Nofal and A. Hekmat, 1983. Effect of acidic and basic amino acids mixtures on quality and ripening of Domiati cheese made from reconstituted milk. Egypt. J. Food Sci., 11: 115-122.

Elfalleh, W., N. Nasri, N. Marzougui, I. Thabti and A. M'rabet *et al*., 2009. Physico-chemical properties and DPPH-ABTS scavenging activity of some ocal pomegranate (*Punica granatum*) ecotypes. Int. J. Food Sci. Nutr., 60: 197-210.

Emmons, D.B., 1993. Factors Affecting the Yield of Cheese. International Dairy Federation, Brussels, Belgium.

Fagan, C.C., M. Leedy, M. Castillo, F.A. Payne, C.P. O'Donnell and D.J. O'Callaghan, 2007. Development of a light scatter sensor technology for on-line monitoring of milk coagulation and whey separation. J. Food Eng., 83: 61-67.

Fahmi, A.H. and H.A. Sharara, 1950. Studies on Egyptian domiati cheese. J. Dairy Res., 17: 312-318.

Farooq, H. and Z.U. Haque, 1992. Effect of sugar esters on the textural properties of nonfat low calorie yogurt. J. Dairy Sci., 75: 2676-2680.

Fayed, E.O., 1982. Studies on the use of some natural flavor agents on the ripening of picked. Ph.D. Thesis, Ain Shams University, Cairo, Egypt.

Fenelon, M.A. and T.P. Guinee, 1999. The effect of milk fat on Cheddar cheese yield and its prediction, using modifications of the Van Slyke cheese yield formula. J. Dairy Sci., 82: 2287-2299.

Fisher, R.A., 1970. Statistical Method for Research Workers. Oliver and Boyed Inc., Edinburgh, pp: 140-142.

Fox, P.F., T.P. Guinee, T.M. Gogan and P.L.H. McSweeney, 2000. Fundamentals of Cheese Science. Springer, USA., ISBN-13: 978-0834212602, Pages: 588.

Ghadge, P.N., K. Prasad and P.S. Kadam, 2008. Effect of fortification on the physico-chemical and sensory properties of buffalo milk yoghurt. Electron. J. Environ. Agric. Food Chem., 7: 2890-2899.

Giusti, M.M. and R.E. Wrolstad, 2005. Characterization and Measurement of Anthocyanins by UV-Visible Spectroscopy. In: Handbook of Food Analytical Chemistry, Water, Proteins, Enzymes, Lipids and Carbohydrates, Wrolstad, R.E., E.A. Decker, S.J. Schwartz and P. Sporns (Eds.). John Wiley and Sons, New York, ISBN: 9780471709091, pp: 19-31.

Gomez, M., F. Ronda, P.A. Caballero, C.A. Blanco and C.M. Rosell, 2007. Functionality of different hydrocolloids on the quality and shelf-life of yellow layer cakes. Food Hydrocolloids, 21: 167-173.

Guo, H., W. Ling, Q. Wang, C. Liu and Y. Hu *et al*., 2007. Effect of anthocyanin-rich extract from black rice (*Oryza sativa* L. *indica*) on hyperlipidemia and insulin resistance in fructose-fed rats. Plant Foods Hum. Nutr., 62: 1-6.

Hassanein, A.M., M.M. Somaya and A.A. Baraka, 2008. Production of soft cheese using buffalo's milk fortified hull-less barley. Egypt. J. Applied Sci., 23: 175-184.

Hefnawy, S., L. El Koussy and S. Ewais, 1984. Manufacture of half cream pickled soft cheese. II. Effect of supplementing cheese milk with skimmilk powder. Egypt. J. Dairy Sci., 12: 251-258.

Herrington, B.L., 2000. Milk and Milk Processing. Green World Publisher, New Delhi, India.

Hosseinian, F.S., W. Li and T. Beta, 2008. Measurement of anthocyanins and other phytochemicals in purple wheat. Food Chem., 109: 916-924.

IDF., 1991. Factors affecting the yield of cheese. Special Issue No. 9301, International Dairy Federation (IDF), Brussels, Belgium.

Larmond, E., 1987. Laboratory Methods of Sensory Evaluation of Food. Canadian Government Publishing Center, Ottawa, ON, Canada.

Ling, W.H., L.L. Wang and J. Ma, 2002. Supplementation of the black rice outer layer fraction to rabbits decreases atherosclerotic plaque formation and increases antioxidant status. J. Nutr., 132: 20-26.

Lu, T.M., C.C. Lee, J.L. Mau and S.D. Lin, 2010. Quality and antioxidant property of green tea sponge cake. Food Chem., 119: 1090-1095.

Matejic, J.S., A.M. Dzamic, T. Mihajilov-Krstev, V.N. Randelovic, Z.D. Krivosej and P.D. Marin, 2012. Total phenolic content, flavonoid concentration, antioxidant and antimicrobial activity of methanol extracts from three *Seseli* L. taxa. Central Eur. J. Biol., 7: 1116-1122.

Minh, N.P., 2014. Different factors affecting to waxy black rice malt production. Int. J. Multidisciplin. Res. Dev., 1: 41-48.

Nasri, N., N. Tlili, W. Elfalleh, E. Cherif, A. Ferchichi, A. Khaldi and S. Triki, 2011. Chemical compounds from phoenician juniper berries (*Juniperus phoenicea*). Nat. Prod. Res., 25: 1733-1742.

Okonogi, S., C. Duangrat, S. Anuchpreeda, S. Tachakittirungrod and S. Chowwanapoonpohn, 2007. Comparison of antioxidant capacities and cytotoxicities of certain fruit peels. Food Chem., 103: 839-846.

Osman, S.G., M.A. Zedan and M.F. Yonis, 2000. Soft cheese like from soy milk Ann. Agric. Sci. Moshtohor, 38: 379-388.

Park, Y.S., S.J. Kim and H.I. Chang, 2008. Isolation of anthocyanin from black rice (Heugjinjubyeo) and screening of its antioxidant activities. Korean J. Microbiol. Biotechnol., 36: 55-60.

Ramakant, S., 2006. Production, Processing and Quality of Milk and Milk Products. International Book Distributing Co. Publishing Division, India.

Rinaldoni, A.N., D.R. Palatnik, N. Zaritzky and M.E. Campderros, 2014. Soft cheese-like product development enriched with soy protein concentrates. LWT-Food Sci. Technol., 55: 139-147.

Saenkod, C., Z. Liu, J. Huang and Y. Gong, 2013. Anti-oxidative biochemical properties of extracts from some Chinese and thai rice varieties. Afr. J. Food Sci., 7: 300-305.

Sompong, R., S. Siebenhandl-Ehn, G. Linsberger-Martin and E. Berghofer, 2011. Physicochemical and antioxidative properties of red and black rice varieties from Thailand, China and Sri Lanka. Food Chem., 124: 132-140.

Thomas, R., W.A. Wan-Nadiah and R. Bhat, 2013. Physiochemical properties, proximate composition and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia. Int. Food Res. J., 20: 1345-1351.

Waller, R.A and D.B. Duncan, 1969. A bayes rule for the symmetric multiple comparisons problem. J. Am. Stat. Assoc., 64: 1484-1503.

Walstra, P., 1993. The Syneresis of Curd. In: Cheese: Chemistry, Physics and Microbiology, Fox, P.F. (Ed.). Chapman and Hall, UK., pp: 141-191.

Weber, F., 1987. Curd Drainage. In: Cheese Making: Science and Technology, Eck, A. (Ed.). Lavoisier, New York, pp: 22-36.