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Research Article
Effect of Wheat Germ on Chemical, Sensory and Technological Properties of Soft Cheese

Nahla Tariq Khalid and Makarim Ali Mosa

Department of Food Science, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq

Abstract

Background and Objective: At present, the dairy industries in many countries have developed improvements in their cheese products through the addition of nonstructural materials such as plant proteins, fresh fruits and vegetables, herbs and other plants that have exhibited possible health benefits. This study aimed to support the structure of soft cheese, manufactured from cow's milk, by adding wheat germ and to evaluate the effect of this additive on its chemical composition, sensory evaluation and rheological properties. **Materials and Methods:** Raw wheat germ was added, at concentrations of 0, 1 and 2%, to coagulate cow's milk for the manufacture of soft cheese. Cheese yield, coagulation time and hardness were estimated. The chemical content of the wheat germ, cow's milk and treated cheeses were studied. The fatty acid content of the germ and the treated cheese was estimated by the GC technique. **Results:** The results showed that the wheat germ had an effect on the time of coagulation, the yield percentage and the cheese hardness. Adding wheat germ led to higher proportions of protein and ash in the cheese compared to the control treatment. This addition also resulted in an increase in the amount of phenolic compound compared to the control treatment. Determination of the fatty acid content indicated that wheat germ had palmitic, stearic, linoleic and oleic acids. Therefore, the addition of wheat germ led to an increase in the amount of those fatty acids in cheese. The cheese product was evaluated in terms of taste, texture, flavor and color and the results were close to the control treatment. **Conclusion:** Wheat germ addition had increased the protein, ash, phenolic compound and fatty acids of the samples. The sensory properties of soft cheese treatments were improved by wheat germ addition. The fortification cheese with wheat germ in the blend gave very good cheese products with high flavor, texture and nutritional benefits. So, it can be nominated for these imitating products for commercial production to serve different categories of consumers.

Key words: Wheat germ, soft cheese, fatty acids, phenolic compounds

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Corresponding Author: Nahla Tariq, Department of Food Science, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq

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

INTRODUCTION

A result of the high nutritional value of cheese and the balanced biological value and sensory indicators, it had become widely available; it is a primary option for different age groups. At present time, the dairy industry in many countries has acquired developments through the addition of non-structural materials such as plant proteins, fresh vegetables and fruits[1], herbs and other plants have exhibited possible health benefits, such as anti-oxidative in thyme (*Thymus vulgaris*) and Beetroot[2,3].

Wheat germ is a by-product of grain milling. It is an important part of the wheat grain. It is consist of 2.5-3.5% of the total weight of the grain, yet it is considered a functional food with high nutritional, health value. It plays an important vital role in human nutrition due to its content such as fat carbohydrate especially sucrose, fiber as well as mineral salts (potassium, magnesium, zinc, phosphorus) and vitamins B group and vitamin E.

In addition, the wheat germ contains some biologically active compounds such as flavonoids, steroids, glutathione, phenols as well as wheat germ was rich in unsaturated fatty acids (oleic, linoleic, alpha linolenic)[4]. Wheat germ is rich protein source of essentially amino acids leucine acid and lysine acid[5].

Using of wheat germ in current environmental conditions have high attention, it improves the resistance of the body to the adverse environmental effects such as contamination of chemicals and radiation because of its special composition.

Chemical studies showed that the wheat germ contains a biologically active compound 18-24% starch 8.6-10.4%, proteins 21.5-28.3% and fat 8-11% with important functional properties such as water absorption[1] of 200%.

Mohamed *et al.*[6] addition wheat germ extracts after heat treatment to Labneh cheese and explained that the cheese produced had a higher level of solids and have more hardness compared with the control treatment also the germ had an effect on starter vitality during storage, the characteristic of the product taste and flavor and tissue acceptable after storage in the cooling at 5°C for 15 days.

Basiony[7] added some fiber-rich materials to dairy products such as wheat germ, oats, Saccharin fiber and barley at 2% of each of them, the results refer to increase in cheese yield, reduced coagulation time, increase in protein, ash and fatty acids content.

Abbas[8] prepared dairy products with wheat germ using Buffalo's Butter milk or sweet whey and proved that wheat germ was high protein 32%, dietary fiber 18.4%, phenolic compound (0.5512.97 g/EAG, total flavonoids 108.31 mg g^{-1} 100), it showed that incorporation of 2 and 3% resulting in acceptable products and the produced milk was yellow, viscous and have anti-oxidant activity compared to control treatment.

Soft cheese characterized by high humidity (25-70%), soft cheese is one of the easiest types of cheeses. It does not usually require heat treatments and the advantage of high humidity in this type makes it more mature than other species[9,10].

The aim of this study was to produce modified soft cheese by adding wheat germ to cow's milk with and evaluate the effect of this additive on chemical composition, sensory evaluation and rheological properties of this product, also the germ had nutrition due to its content such as fatty acids, carbohydrate especially sucrose, fiber as well as mineral salts (potassium, magnesium, zinc, phosphorus) and vitamins B group and vitamin E.

MATERIALS AND METHODS

Location research and sampling: This study was performed at Department of Food Science and the integrated research and testing laboratory, The University of Baghdad in the period of January-April, 2018.

Full-fat cows' milk was obtained from Animal Field Department, Faculty of Agricultural Engineering Sciences, University of Baghdad, Iraq. Microbial rennet used was produced by Meito Sangyo Co. Ltd. The local wheat germ was provided from the Durra mill, Baghdad, Iraq. Salt (NaCl) purchased from local market.

Milk analyzer method was used to determine milk composition fat, solids not fat, protein, lactose, salt, pH and density.

The wheat germ was grind using the electric grinder. Cheese treatments were made according to Vasek *et al.*[11]. Fresh cows' milk was pasteurized at 63°C for 30 min, cooled to 35°C and divided into three batches. Control cheese treatment (A) was made without adding wheat germ and the other two treatments (B, C) were made by adding of milk weight at 1 and 2% wheat germ. About 1% rennet was added to the three treatments milk and left a period of time until coagulation and the coagulation time was evaluated.

Physiochemical treatments analysis: After coagulation complete, the curd was cut into cubes, 2.5% salt was added to the curd, each cheese treatments were taken out and weighted for calculating cheese yield. The chemical composition of cheese treatments were analyzed for moisture, fat, ash according to AOAC[12]. The GC technique (GC 2010,

Shimadzu, Japan) was used to determine total volatile fatty acids (TVFA) which were estimated by the method of Ortega[13], using fatty acids standard of palmitic, oleic, linoleic, stearic and linolenic (from Sigma, St. Louis, MO, USA).

The total protein of wheat germ and cheese treatments were estimated by the Kjeldahl method AOAC[14] and phenolic compounds according to Zilic *et al.*[15].

The strength of curd hardness was estimated using a device (TLS-CDM.01/05), the cheese sample was cut by 1 cm^2, placed on a graph paper on an estimated area 1 cm^2, the machine was loaded with the cheese sample at a speed of 50 mm min^{-1} until the piece of cheese is crushed, the reading was recorded in units of newton/cm^2 as described by Korolczuk and Mahaut[16].

Sensory evaluation: Cheese samples were evaluated by the staff members of Food Science Dept./College of Agricultural Engineering Sciences/University of Baghdad.

The evaluation of different characteristics were conducted according to the form prepared for this purpose which were the taste, texture, smell, flavor and color and by reality 0-10°, zero represents the minimum level and 10 represent the maximum level as described by El-Shafei *et al.*[17].

Statistical analysis: The full random design was used (CRD) to study the effect of treatment in different characteristics. Significant differences among the averages were compared with the test less significant difference (LSD)were determined at $p \leq 0.05$. The Statistical Analysis System SAS[18] was used to show the effect of different factors appearance.

RESULTS AND DISCUSSION

Table 1 showed percentages of moisture, fat, protein, lactose, ash, total solids and non-fat solids for whole-fat bovine milk used in the soft cheese processing. These were 87.00, 4.90, 2.95, 4.49, 0.67, 13.01 and 8.11%, respectively. The pH and corrective acidity (calculated on the basis of lactic acid) and the specific weight were 6.4, 0.16 and 1.029%, respectively, which were within the natural limits of raw milk and they were close to which found by Al-Sheraji[19] and Al-abadi[20].

Table 2 showed the time of coagulation, the percentage of yield and the strength curd hardness of treatments. It was noted that low time required for milk coagulation in addition of wheat germ (37, 32 and 29 min for A, B and C) treatments. The addition of wheat germ to milk was led to an increase in yield (%) (18.8 and 19.5%) for A, B and C treatments and this was in agreement with Basiony[7]. It was also observed at the same Table 2 that the strength of coagulation increased with the increasing in wheat germ percentage as it was 111, 128 and 150 N cm^{-2} for A, B and C, respectively. It was in agreement with Mohamed *et al.*[5]. The high hardness of the cheese was due to the low moisture content of the cheese (Table 2), this result in agreement with Naseef and Merza[21], This was due to the increase in total solids associated with a reduced moisture content of cheese during storage[22].

Table 1: Chemical composition of whole raw bovine milk and some chemical and physiological properties

Composition	Percentage
Moisture	87.00
Fat	4.90
Protein	2.95
Lactose	4.49
Ash	0.67
Total solid	13.01
Solid non-fat	8.11
pH	6.40
Total acidity	0.16
Specific weight	1.029

Table 2: Time of coagulation, yield and strength curd hardness of cheese treatments

Treatments	Time of coagulation (min)	Yield (%)	Curd hardness (newton/cm^2)
A	37	18.8	111
B	32	19.5	128
C	29	19.5	150

Table 3 referred to wheat germ content of moisture, protein, ash and fat, 13, 35, 5.5 and 13%, respectively, it was close to that found by Abbas[8]. Both Kalpana and Vali[23] indicated that wheat germ protein content ranged from 18-26% and it was related to its purity and was not contaminated with bran or endosperm during isolation. The high protein content of wheat germ made it suitable for supporting low protein foods also high level of essential amino acids also makes a rich source of nutritional value.

Table 3 also showed the percentage of fat (13%) indicated that the fat content of wheat germ was related to extraction ratio, solvent type, wheat variety and fat purity[24]. The percentage of ash was 5.5%, which was high compared to Gômez *et al.*[24] increasing in ash percentage was due to the fact that most of the mineral elements were concentrated in the germ and the outer layers of the grain[25]. The difference in the values of the chemical estimation of wheat germ was due to the difference in the mechanism and methods of isolation in mills.

Table 3 showed the chemical composition of soft cheese treatments (A, B, C), moisture content of cheese were (60.74

Table 3: Chemical composition of varieties of soft cheese and wheat germ

Composition (%)	Wheat germ	LSD	A	B	C
Moisture	13.0	1.22	60.74	53.96	45.88
Protein	35.0	2.33	13.125	15.312	18.593
Ash	5.5	1.34	1.33	2.49	4.05
Fat	13.0	0.90	17.00	17.70	13.51
Phenolic compounds (µg gallic acid/g)	450.0	4.00	0.90	102.00	119.00

Table 4: Fatty acids content of wheat germ and cheese treatments

Treatments	Linoleic acid (%)	Oleic acid (%)	Stearic acid (%)	Palmitic acid (%)
Wheat germ	32.9	29.3	44.9	13.4
A (control)	60.0	55.3	37.8	38.0
B	87.2	65.5	93.9	47.0
C	98.3	88.3	110.2	91.1

Table 5: Sensory evaluation of soft cheese produced

Treatments	Textures	Taste	Color	Odor
A	8.80	8.40	9.60	9.00
B	8.40	7.60	8.20	8.20
C	8.20	7.40	7.20	7.40
LSD	0.608	0.237	0.01	0.003

and 53.96%) for A and B treatments this was in agreement with result of Al-Sheraji[19]. This result was consistent with the findings of Al-Sharaji[19] of Iraqi soft cheese (59.00%), the limits of the Iraqi standard (1988) for the moisture content in soft cheese that not less than 50%. While the moisture in the C treatment decreased by 45.88%.

Table 3 showed an increase in the protein percentage at A, B and C treatments 13.12, 15.31 and 18.59%, respectively. This was in line with the results of Basiony[7] that the addition of 2% wheat germ to soft cheese led to increase in protein and ash, fat percentage of the cheese treatments was appeared in Table 3, it was 17 and 17.7% for the cheese of treatment A and B. This value was very close to value which found by Doosh *et al.*[26] and differs from what Sedrah[27] found for soft cheese of 18.0%, a fat percentage in the treatment C was very low compared to the cheese of treatment A and B at 13.51%. This is high protein content due to the increased concentration of solids by adding the wheat germ to the milk.

The results were shown in Table 3. The percentage of ash in the various cheese treatments. Ash value of treatment A was 1.33% and was similar to Qader[28] for soft cheese of 1.40%, they were 2.49 and 4.05% for B and C, respectively, an increase in the percentage of ash in cheese samples B and C compared to the control treatment due to the addition of the wheat germ, El-Baz and Azza[29] referred that addition of wheat germ led to increase ash content in cheese sample.

Table 3 also showed the phenolic compounds content of wheat germ, with a 450 µg gallic acid/g. The addition of the wheat germ resulted in an increase in the phenolic compounds in the cheese produced in B and C treatments with 102 and 119 µg gallic acid/g, respectively. It was concluded that the addition of wheat improves the active biological compound. Abbas *et al.*[8] reported that phenolic compounds in wheat germ 0.55 µg gallic acid/g. Al-Tameemi[30] also reported that the phenolic compound content of wheat germ produced from local mills was 4.1 mg gallic acid/g.

Table 4 showed the content of some fatty acids in the wheat germ, linoleic and oleic acid was 32.9 and 29.3% while their contents of stearic and palmitic were 44.9 and 13.4%. The addition of wheat germ by 1 and 2% of the weight of milk resulted in an increase in the content of these acids in the cheese product was the palmitic 47.0 and 91.1% compared to the control treatment 38.0% and the content of the stearic increased to 93.9 and 110.2% in cheese product of B and C treatments, oleic content of the cheese containing 1 and 2% of the wheat germ increased to 65.5 and 88.3% in B and C treatments compared to the cheese sample for the control treatment A (55.3%), linoleic percentage was 87.2 and 98.3% compared to the control sample 60.0%.

To the percentage of palmitic, oleic, linoleic and linolenic fatty acids in wheat germ. Ozcan *et al.*[4] explained the percentage of fatty acids palmitic, oleic, linoleic and linolenic in wheat germ were 15.89, 15.48, 54.88 and 7.34%, respectively, Wang and Johson[31] referred that wheat germ oil had high level of unsaturated fatty acids.

The sensory evaluation of cheese samples were conducted by a group of experienced and specialized food science membrane. The sensory evaluation form included four qualities that could determine the quality of cheese sample namely texture, taste, color and odor. Table 5 showed the results of the sensory evaluation of the control cheese sample

A and the cheese samples of the treatments B and C immediately after processing, The results showed that the control treatment cheese A had a higher score in quality parameter compared with B and C samples, The results also showed that the soft cheese of B treatment had the highest degree of sensory evaluation compared to the C treatment. This was in line with what Basiony[7] found and that additions of wheat germ have improved sensory properties of soft cheese. The treatments with wheat germ were less white in color compared to the control treatment, as the small germ molecules act as centers to disperse light and thus reduce whiteness.

The study obtained the potential combing anther dairy products with various cereal byproducts like wheat bran, Rhy bran and corn germ.

Studying the functional properties of wheat germ in order to use it in another dairy products like ice cream as a stabilizer or emulsifier.

CONCLUSION

These results suggest that the addition of wheat germ led to an increase in the ratio of protein, ash, phenolic compound and fatty acids in the cheese. The addition of wheat germ has improved the sensory properties of soft cheese.

SIGNIFICANCE STATEMENT

This study confirmed that addition wheat germ to cheese and explained that the cheese produced had a higher level of solids and have more hardness compared with the control treatment also the germ had nutrition due to its content such as fatty acids, carbohydrate especially sucrose, fiber as well as mineral salts (potassium, magnesium, zinc, phosphorus) and vitamin B group and vitamin E.

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REFERENCES

1. Zakharova, L.M., 2014. Development and introduction of new dairy technologies. Foods Raw Mater., 2: 68-74.
2. Nahla, T.K., S.U. Wisam and N.M. Tariq, 2018. Antioxidant activities of beetroot (*Beta vulgaris* L.) extracts. Pak. J. Nutr., 17: 500-505.
3. Wisam, S.U., T.K. Nahla and N.M. Tariq, 2018. Antioxidant activities of thyme extracts. Pak. J. Nutr., 17: 46-50.
4. Özcan, M.M., A. Rosa, M.A. Dessi, B. Marongıu, A. Piras and F.Y.I. Al-Juhaimi, 2013. Quality of wheat germ oil obtained by cold pressing and supercritical carbon dioxide extraction. Czech J. Food Sci., 3: 236-240.
5. Arshad, M.U., F.M. Anjum and T. Zahoor, 2007. Nutritional assessment of cookies supplemented with defatted wheat germ. Food Chem., 102: 123-128.
6. Mohamed, S.H.S., F.L. Seleet, A.B. Abd El-Khalek and F.A. Fathy, 2015. Effect of wheat germ extract on the viability of probiotic bacteria and properties of labneh cheese. Res. J. Pharm. Biol. Chem. Sci., 6: 674-682.
7. Basiony, M.M., 2013. The effect of some nutritional additives on the properties of some dairy products. Ph.D. Thesis, Dairy Science Department, Faculty of Agriculture, Mansoura University, Egypt.
8. Abbas, H.M., A.M.S. Hussein, F.L. Seleet, H.M. Bayoumi and M. Abd El-Aziz, 2015. Quality of some dairy by-products supplemented with wheat germ as functional beverages. Int. J. Dairy Sci., 10: 266-277.
9. El-Manfalot, M.M.H., 2010. Nutritional and biological assessment of wheat germ and its effect on immune system in the experimental rats. Ph.D. Thesis, Faculty of Education, Ain Shams University, Cairo, Egypt.
10. Youssef, M.K.E., 2012. Guide for healthful nutrition of cancer patients. South Egypt Institute of Cancer. Assiut University. Assiut (In Arabic).
11. Vasek, O.M., S.M. Mazza and G.S. Giori, 2013. Physicochemical and microbiological evaluation of corrientes artisanal cheese during ripening. Food Sci. Technol., 33: 151-160.
12. AOAC., 2000. Official Methods of Analysis. 17th Edn., Association of Official Analytical Chemist, Washington, DC., USA.
13. Lobos-Ortega, I., I. Revilla, M.I. Gonzalez-Martin, J.M. Hernandez-Hierro, A. Vivar-Quintana and C. Gonzalez-Pérez, 2012. Conjugated linoleic acid contents in cheeses of different compositions during six months of ripening. Czech J. Food Sci., 3: 220-226.
14. AOAC., 2002. Official Methods of Analysis. 17th Edn., AOAC., Washington DC., USA.
15. Zilic, S., A. Serpen, G. Akıllıoglu, M. Jankovic and V. Gokmen, 2012. Distributions of phenolic compounds, yellow pigments and oxidative enzymes in wheat grains and their relation to antioxidant capacity of bran and debranned flour. J. Cereal Sci., 56: 652-658.
16. Korlczuk, J. and M. Mahaut, 1990. Relaxation studies of acid type cheese texture by a constant speed cone penetrometric method. J. Texture Stud., 21: 107-122.
17. El-Shafei, H., A. Wahba, F. El-Abbasy and A. Sameh, 1995. Manufacture of Ras cheese with different milk clotting enzymes. Egypt. J. Dairy Sci., 23: 271-283.
18. SAS., 2012. Statistical Analysis System User's Guide: Statistical. Version 9, 1st Edn., SAS Institute Inc., Cary, NC., USA.

19. Al-Sheraji, S.H., 2002. Using of calotropis procera protease in soft cheese making and acceleration ripening of monterey cheese. MSD. Thesis, University of Baghdad, Iraq.
20. Al-Abadi, M.M.K., 2014. Activity of some probiotics in dairy ferminted milk and soft cheese. MSD. Thesis, University of Baghdad, Iraq.
21. Nasif, Z.M. and R.A. Mirza, 2012. The uses of *Lactobacillus plantarum* metabolites locall isolated in biopreservation for some foods. Euphrates J. Agric. Sci., 4: 93-108.
22. Nikjooy, S., G.J. Maryam and S.J. Shima, 2015. The effect of various concentrations of salep gum on physicochemical characteristics of low-fat white cheese. Int. J. Agric. Crop Sci., 8: 136-141.
23. Jadhav, K. and S.A. Vali, 2009. Proximate composition of wheat germ based products. J. Dairying Foods Home Sci., 28: 241-243.
24. Gômez, M., J. Gonzâlez and B. Oliete, 2012. Effect of extruded wheat germ on dough rheology and bread quality. Food Bioprocess Technol., 5: 2409-2418.
25. Kumar, K.A., G.K. Sharma, M.A. Khan, T. Govindaraj and A.D. Semwal, 2015. Development of multigrain premixes-its effect on rheological, textural and micro-structural characteristics of dough and quality of biscuits. J. Food Sci. Technol., 52: 7759-7770.
26. Doosh, K.S., A.J. Al-Musawi and L.A. Al-Husseini, 2012. Study the effect of addition mustard and its oil in improving the sensore evaluation and shelf life of Iraqi soft cheese. J. Kerbala Univ., 10: 1176-1183.
27. Sedrah, Z.T., M.A.S. Amer and M.A. Ghazi, 2014. Extraction, purification and characterization of protease of *Pseudomonas fluorescens* ISH and it's role in deterioration of Iraqi soft cheese. Ph.D. Thesis, University of Baghdad, Iraq.
28. Qader, R.S., 2013. Preparation of protein co-precipitate from cow milk and study some of its chemical and physical properties. MSc. Thesis, University of Salahaddin-Erbil, Iraq.
29. El-Baz, A.M., 2013. The use of inulin as a dietary fiber in the production of synbiotic UF-soft cheese. J. Food Dairy Sci. Mansoura Univ., 4: 663-677.
30. Al-Tameemi, E.K.A., 2018. Using wheat germ in manufacturing probiotic fermented milk products and studying some their properties. MSD. Thesis, University of Baghdad, Iraq.
31. Wang, T. and L.A. Johnson, 2001. Refining high-free fatty acid wheat germ oil. J. Am. Oil Chem. Soc., 78: 71-76.