The Utilization of Wheat Germ in Burger Preparation

*Mahmoud F. S. Kadous , ** Saad A. Mahgoub and ** Walid, M. Shehata

*Meat and Fish Research Department and **Crops Technology Research. Department, Food Technology Research Institute, Agriculture Research Center, Giza, Egypt.

Abstract

The present study was aimed to investigate the possibility of utilizing wheat germ extrudate in beef burger preparation as a substitution of beef meat by (5, 10, 15 and 20% levels). Chemical, physical and sensory characteristics of prepared burger were determined. By increasing the wheat germ extrudate levels, carbohydrate, fiber and ash were significantly increased, while total protein and fats were significantly decreased. Also, by increasing the added levels of wheat germ extrudates, Mg, K, Mn, Zn and P were significantly increased while; Fe, Na and Ca were significantly decreased. The substitution of beef meat with wheat germ extrudate significantly enhanced the chemical and physical quality attributes of produced burger (TVN, TBA, pH, WHC and plasticity). The best Quality attributes were achieved at 10% level compared to control. So, we recommend adding wheat germ extrudate at 10% level in beef burger preparation.

Keywords: Beef burger, extruded wheat germ, Chemical and physical quality attributes and sensory evaluation

Introduction

Wheat germ is a part of the kernel, approximately 2.5% in total product. It is a byproduct of the flour milling industry which appears a potential source of total proteins and is reported to be competable to animal total proteins for human consumption besides being an excellent source of tocopherol, B group vitamins and oil. Also, it contains 23 nutrients and has more nutrient per gram than any other vegetable or grain **(Kalpana and Vali, 2009 and Sahar, 2012)**

Wheat germ contains moisture (5.1-5.13%)**,** total protein (18.8-24.81%), ash (1.4-1.65%), fat (6.55-10.1%), fiber (1.4-1.48%) and carbohydrates (60.4-64.4%). Raw wheat germ contain 10% oil is mainly used in nutrition and cosmetic industries as a source of oil **(Kahlon, 1989).** Wheat germ contains 28% total protein and has more total protein than can be found in most meat products **(Brouce, et al. 1997).** Wheat germ contains potassium and iron higher than any other grain. Also quantities of calcium, zinc, magnesium and vitamins A, B_1, B_2 and E were found in wheat germ **(Fraser, et al. 1992) and (Spiller and Jenkins, 1992).**

Meat industry is continues updating to improve eating quality characteristics and palatability attributes which are the major determine of consumer acceptance and preference. The retail sale of beef-burger is a big business. High meat prices prompted the meat producers in Egypt to produce various meat brands extended with non-meat ingredients. However maintaining the nutritional contribution organoleptic and textural properties of meat products is matter of challenge, which necessitates more effort to protect the product integrity, taste, flavor and textural sensory attributes **(Gehan and Emara, 2010).**

Non- meat total protein were added to improve water binding stabilize fat. Vegetable products are added to raw or cooked meat products to improve its functional properties, nutritional value and sensory qualities. Most of meat products are rich in fat, but deficient in complex carbohydrates **(Serdaroglu and Degirmencioglu, 2004) and (Turhan, et al. 2007).**

Vegetable products play an important role in human nutrition as a provide essential minerals and vitamins **(Yue, 2001).** It can also be used to replace part of the animal fat with its hydrating capacity and replace part of the animal meat with vegetable products considerably decrease the final cost of meat products **(Mizutani and Hashimoto, 2004).** Also, it serve as, fillers, fat replacers and source of dietary fibers and natural antioxidants in meat system **(Hedrick, et al. 1994).**

The present study was aimed to investigate the possibility of utilizing wheat germ extrudate in beef burger preparation as a substitution of beef meat by (5, 10, 15 and 20% levels) and maintain the quality attributes, Chemical, physical and sensory characteristics of beef burger.

Materials and Methods

Raw materials.

Refrigerated beef meat was obtained from supper market, Egypt. Immediately after purchasing, samples were transported using ice box to the laboratory of Meat and Fish Technology, Food Technology Research Institute, Agriculture Research Center, Giza, Egypt. Other ingredients such as soy protein, wheat germ, salt, onion, spices, garlic, starch were purchasing from local market at Giza.

Adjusting moisture content of wheat germ before extrusion.

The amount of water was added to bring 1000 grams of sample to the desire moisture level

extrusion and it was calculated according to the following equation:

(Water added = moisture desired %-moisture samples x 10^3 /100 - moisture desired %)

.Water was added gradually to the samples and mixed for 5 minutes by mechanical mixer. The samples were placed in plastic bags and kept for 24 hrs at 4ºC to equilibrate the moisture according to (**EL-Dash, 1985**).

Extrusion conditions.

A Model BC21co-rotating Clextral twin screw extruder with intermeshing screws (Clextral, Firminy Cedex, France) and 3 mm diameter circular die was used. The unit was operated at flow rate of (12 kg /hr) and 400 rpm screw speed. Temperature profile in the four barrel sections from the feed end were set at 150ºC by according to (**Supat**, *et al.* **2008**).

Preparation of burger.

Refrigerated beef meat was manually cut using band saw and minced through (24 mm plate)and divided into four formulas and control. Mix the ingredients of control formula (beef meat 78% , soy protein 10% , minced garlic 1% , minced onion 4.45% , salt 2% , spices 2%, white pepper 0.5%, Na pyrophosphate 0.5%, cumin 1% and starch 1%. Formula$_1$(beef meat 73%, wheat germ 5%), Formula$_2$ (beef meat 68% , wheat germ 10%), Formula$_3$ (beef meat 63% , wheat germ 15%) and Formula$_4$ (beef meat   58% , wheat germ 20%) and the other ingredients were added to all formulas with the same level. The formulas were separately then formed into discs of 100g, kept frozen at -18C°, samples were then taken for analysis.

Chemical analysis.

Proximate analysis including moisture, total protein, fat, ash and fiber were carried out according to the methods of (**AOAC, 2005**). Carbohydrates content was calculated by difference. Magnesium, sodium, potassium, manganese, iron, calcium and zinc were determined according to (**AOAC, 2005**). Perkin Elmer (Model 3300, USA) Atomic Absorption Spectrophotometer was used to determine these minerals.

Total phosphorous was determined using

common colorimetric method described by (**AOAC,1995**).

Physiochemical evaluation.

Total volatile nitrogen (T.V.N) was determined according to (**Winton and Winton, 1958**), thiobarbituric acid (T.B.A) value was determined according to (**Pearson, 1970**) and pH value was determined to (**Aitken,** *et al*. **1962**). The water holding capacity (W.H.C.) and plasticity were measured by filter press methods of (**Soloviev, 1966**). Cooking loss of samples was calculated as percentage of weight change from raw to cooked state.

Sensory evaluation.

Sensory evaluation was determined according to (**Suderman,** *et al.* **1981**). Immediately after preparing of burger, samples were prepared by frying in plant oil for (5-10 min) and subjected to member's trained sensory panel to find out the formulas that have more palatability by evaluating color, odor, texture and overall acceptability of these formulas.

Statistical analysis.

The obtained data were exposed to analysis of variance followed by multiple comparisons between means (P≤ 0.05) applying LSD. The analysis was carried out using the PRO ANOVA procedure of Statistical Analysis System (**SAS Program, 1996**).

Results and Discussion

Chemical composition of raw and extruded wheat germ.

Chemical composition results of wheat germ (raw and extrudate) are shown in Table (1). The data showed that there was a significant difference (P≤ 0.05) between raw and extrudate wheat germ. Where, showed that moisture, total protein, fat, fiber, ash and total carbohydrates were (7.4 and 9.43%) , (30.8 and 29.5%), (8.23 and 7.64%), (4.3 and 3.76%) , (4.63 and 5.16%) and (44.54 and 44.51%), respectively. The results are in accordance with those reported by (**Al-Hooti,** *et al*. **2002**).They mentioned that proximate composition of wheat germ were moisture 8% , total protein 30%, fat 9%, fiber 3.5%, ash 4% and total carbohydrates 45.5%.

Table 1.Chemical composition of wheat germ (raw and extruded). (On wet weight basis)

| Properties | Wheat germ (g/100g) | | *LSD* |
	Raw	Extruded	
Moisture	7.4±0.2[b]	9.43±0.9[a]	0.5152
Total protein	30.8±1.5[a]	29.5±0.5[b]	0.8972
Fat	8.23±1.45[a]	7.64±0.25[b]	0.8277
Fiber	4.3±1.2[a]	3.76±0.15[b]	0.4034
Ash	4.63±0.21[b]	5.16±0.85[a]	0.5235
Total carbohydrates	44.54±0.05[a]	44.51±0.01[a]	0.0358

Values are means for 3± SD. There is significant difference between two means have the letter (P >0.05).

Mineral contents of raw and extruded wheat germ.

Data presented in Table (2) showed that, the wheat germ is a good source of mineral such as potassium and phosphorus. The data in the same table showed significant differences between raw and extrudate wheat germ of the minerals contents. Where, wheat germ raw and extrudate were containing magnesium (303 and 294 mg/100g), sodium (93.3 and 91.7mg/100g), potassium (954and 934mg/100g), manganese (13 and 11 mg/100g), iron (9 and 8.7 mg/100g), calcium(47 and 42 mg/100g), zinc (8.4 and 9.2 mg/100g) and phosphorus (639 and 632 mg/100g) ,respectively. These data indicated that thermal extrusion lead to a slight reduction of the minerals. The results are in accordance with those reported by **(Sahar, 2012)** who mentioned that proximate mineral of wheat germ magnesium (301mg/100g)), potassium (1039 mg/100g),iron (7.2 mg/100g), calcium(46 mg/100g),zinc (8.5 mg/100g)and phosphorus (645 mg/100g

Table 2 . Mineral contents of raw and extruded wheat germ**.**

Prosperities	Wheat germ (Mg/100g)		*LSD*
	Raw	Extruded	
Magnesium	303 ± 4.2^a	294 ± 2.1^b	1.925
Sodium	93.3 ± 3.8^a	91.7 ± 1.5^b	2.138
Potassium	954 ± 5.1^a	934 ± 2.5^b	1.654
Manganese	13 ± 2.0^a	11 ± 1.0^b	0.584
Iron	9 ± 1.0^a	8.7 ± 0.5^a	0.736
Calcium	47 ± 1.5^a	42 ± 0.53^b	0.462
Zinc	8.4 ± 0.5^a	9.2 ± 0.2^a	0.524
Phosphorus	639 ± 2.5^a	632 ± 1.5^b	0.762

Values are means for 3± SD. There is significant difference between two means have the letters (P ≤0.05).

Chemical composition of burger substituted with extruded wheat germ.

Data in Table (3) indicated that moisture level in the control sample is higher than the other formulas and there were significant differences between all formulas There is no significant difference between two means have the letter (P >0.05). Where, the protein and fat simply reduced, ash and fiber simply increased, by increasing the amount of wheat extruded wheat germ in the studied formulas carbohydrates were significantly increased in compared to control. This may be due to wheat germ contains a high percentage of carbohydrates 50.49% proximately **(kalpana and Vali, 2009).**

Table 3. Chemical composition of burger substituted with extruded wheat germ (g/1oog). (On wet weight basis).

Prosperities	Control	F_1	F_2	F_3	F_4	*LSD*
Moisture	66.9 $\pm0.5^a$	61.6 $\pm0.41^b$	60.7 $\pm0.32^c$	59.3 $\pm0.25^d$	58.2 $\pm0.15^e$	0.0236
Total protein	21.6 $\pm0.35^a$	21.5 $\pm0.34^a$	20.4 $\pm0.23^b$	20.2 $\pm0.21^b$	19.4 $\pm0.15^c$	0.0933
Fat	3.4 $\pm0.22^a$	3.24 $\pm0.18^b$	3.15 $\pm0.16^b$	2.83 $\pm0.12^c$	2.45 $\pm0.08^d$	0.0261
Ash	2.73 $\pm0.03^e$	3.15 $\pm0.07^d$	3.34 $\pm0.11^c$	3.55 $\pm0.15^b$	3.66 $\pm0.19^a$	0.0335
Fiber	1.17 $\pm0.04^e$	1.23 $\pm0.08^d$	1.47 $\pm0.12^c$	1.73 $\pm0.15^b$	1.94 $\pm0.21^a$	0.0230
Total Carbohydrates	4.2 $\pm0.1^e$	9.28 $\pm0.12^d$	10.94 $\pm0.36^c$	12.39 $\pm0.06^b$	14.35 $\pm0.26^a$	0.0195

Values are means for 3± SD. There is significant difference between the letters (P >0.05).

Mineral contents of burger substituted with extruded wheat germ.

Data in Table (4) represents the mineral contents burger substitution with extruded wheat germ. It could be noticed that the level of magnesium, potassium, manganese, zinc and phosphorus contents were significantly increased, with the adding level of wheat germ, where, that F4 had the highest content of magnesium, potassium, manganese, iron, zinc and phosphorus followed by F3, 2, 1 and control respectively.

While the level of sodium, iron and calcium decreased with increasing the added level of extruded wheat germ. This may be due to wheat germ is a very rich with potassium, zinc and phosphorus (**Fraser,** *et al.* **1992) and (Spiller and Jenkins, 1992).** Also, may be due to decreasing the moisture content and increasing of the ash content as shown in the table (4) as results of increasing of addition wheat germ.

Table 4. Mineral contents of burger substituted with extruded wheat germ. (mg/100g).

Elements	Control	F_1	F_2	F_3	F_4	*LSD*
Magnesium	81.4 ±1.95[d]	85.5 ±0.86[c]	89.2 ±2.1[b]	92.6 ±1.1[a]	94.7 ±0.96[a]	0.6894
Sodium	196.6 ±2.89[a]	192.5 ±2.1[b]	185.5 ±1.22[c]	132.6 ±0.56[d]	111.4 ±1.87[e]	0.5951
Potassium	225.6 ±1.2[e]	232.5 ±0.75[d]	266.9 ±1.35	289.1 ±1.56[b]	296.5 ±0.85[a]	0.1500
Manganese	18.8 ±0.71[e]	19.1 ±0.46[d]	28.2 ±0.7[c]	43.8 ±0.45[b]	57.7 ±0.44[a]	0.0281
Iron	13.4 ±0.2[a]	13.1 ±0.3[b]	12.7 ±0.22[c]	12.2 ±0.55[d]	11.8 ±0.5[e]	0.0262
Calcium	373 ±3.0[a]	362.3 ±2.51[b]	345.3 ±2.52[c]	326 ±3.0[d]	312.3 ±2.54[e]	0.3489
Zinc	87.5 ±0.36[e]	91.7 ±1.5[d]	103 ±2.0[c]	123 ±3.0[b]	136 ±4.0[a]	0.3941
Phosphorus	165 ±2.7[e]	171 ± 1.2[d]	178 ±1.6[c]	184 ±1.9[b]	192 ±2.4[a]	0.2572

Values are means for 3± SD. There is significant difference between the letters (P >0.05)

Chemical quality attributes of burger substituted with extruded wheat germ.

Results found in Table (5) showed chemical quality attributes of burger for with extruded wheat germ and control, it could be noticed that control recorded the highest value of T.V.N. followed by formula 1, 2, 3 and 4 respectively. So may be there is a direct between total protein content and T.V.N. level.

According to **(Egyptian Organization Standardization, 2005)** minced meat mixed with soya bean total protein should not be contained T.V.N. more than 20 mg/100g (w.w). It is clear that this level not exceeded this amount as all samples had less T.V.N. than the allowance. It could be noticed that, the control had the highest value of pH followed by formula 1, 2, 3 and 4 respectively. This may be confirmed by the relatively higher T.V.N.

Table (5) of control than formula1, 2, 3 and 4, this may be explain in the higher PH value for control than the letter formula **(Sanchez-Alonso, *et al.* 2007).**

It could be noticed that control recorded the highest value of T.B.A followed by formula 1, 2, 3, 4 respectively. This may be attributed to a higher fat content Table (5) may be there is a direct correlation between fat content and T.B.A value According to **(Egyptian Organization Standardization, 2005)** minced meat mixed with soya bean total protein should not be contained T.B.A more than 0.9 mg malonaldehyde /kg (w.w.). It is clear that this level did not exceeded also, all samples were below the permitted. The data in the same table showed that there are significant differences between the control and the rest of the formulas in the chemical quality attributes.

Table 5. Chemical quality attributes of beef burger substituted with extruded wheat germ (On wet weight basis).

Prosperities	Control	F1	F2	F3	F4	*LSD*
T.V.N.	11.3 ±0.3[a]	10.9 ±0.21[ab]	10.7 ±0.15[b]	10.4±0.1[c]	10.1 ±0.1[c]	0.0419
pH	6.32 ±0.08[a]	6.3 ±0.06[b]	6.25 ±0.04[c]	6.21±0.07[d]	6.18 ±0.03[e]	0.0182
T.B.A.	0.292 ±0.009[a]	0.283 ±0.006[b]	0.278 ±0.003[c]	0.255 ±0.007[d]	0.231 ±0.01[e]	0.0024

Values are means for 3± SD. There is significant difference between the letters (P >0.05).
T.V.N. : Total volatile nitrogen (mg/100mg)
T.B.A. : Thiobarbituric acid (mg malonaldehyde/kg)

Physical quality attributes of burger substituted with extruded wheat germ.

From data presented in table (6) It could be noticed that formula (4) recorded the best value of Water Holding capacity and followed by formula 3, 2, 1 and control respectively, so maybe there is reflection correlation between water holding capacity and fat content table (1), it is known that fat is hydrophobic substance water repelling and do not

bland with water with emulsifying, also maybe there is due to the high percentage of carbohydrates, which increased by increasing addition of wheat germ, where that carbohydrate works as a binder, where there is positive relationship between carbohydrate and water holding capacity.

From the obtained data presented in the same Table (6) plasticity (as indicator for texture) was completely affected by the level of water holding

capacity, therefore, plasticity of formula (4) was the best value (due to it had the best value for water holding capacity) followed by formula 4, 3, 2, 1and control.

From the same Table (6) It could be noticed that cooking loss (%) of formula (4) was the best value (the most low) followed by F 3, 2, 1 and control. This was also in accordance reverse with the level of water holding capacity indicating that the better of water holding capacity the lower of the cooking loss was found. The data in the same table showed that there are significant differences between the control

and the rest of the formulas in the physical quality attributes.

These results are similar with those reported by **(Anae and Josefphf, 1996)** who found a quality characteristics of ground beef patties, supplemented with hydrated wheat germ total protein flour at levels 2.0, 3.5, and 5.0% were studied. Water holding capacity decreased and pH increased with addition of water activity was not affected. Supplemented beef patties had lower cooking losses and changes in diameter and higher yields than control patties. Substitution beef patties exhibited lower shear force and compression values than all-meat patties.

Table 6. Physical quality attributes of burger substituted with extruded wheat germ.

Prosperities	Control	F1	F2	F3	F4	*LSD*
W.H.C. (Cm^2/0.3 gm)	5.1 $\pm0.3^a$	4.6 $\pm0.4^a$	3.63 $\pm0.15^b$	3.1 $\pm0.2^b$	2.23 $\pm0.3^c$	0.1636
Plasticity (Cm^2/0.3 gm)	6.2 $\pm0.16^c$	6.4 $\pm0.1^c$	6.93 $\pm0.45^b$	7.2 ± 0.1^a	7.5 $\pm0.2^a$	0.2095
Cook in loss	28.3 $\pm1.52^a$	27 $\pm1.2^{ab}$	25.6 $\pm0.7^b$	23.5 $\pm0.15^c$	18.7 $\pm1.1^d$	0.4115

Values are means for 3± SD. There is significant difference between the letters ($P >0.05$).
W.H.C.: Water Holding capacity

Sensory evaluation of burger substituted with extruded wheat germ.

Sensory evaluation score (color, taste, odor, texture and overall acceptability) were evaluated by the panelists burger in Table (7). From the table (7) the results showed that the formula (2) gave the highest total score 79.7%, followed by yellow Meanwhile, formula (4) gave the lowest total score 71.86% mean while control recorded 87.36%.

From the obvious results, it could be recommended that the best substitution level 10%

from formulas (beef meat (68%), wheat germ (10%), soy total protein(10%), minced garlic (1%), minced onion (4.45%), salt (2%), specie (2%), white pepper (0.5%), Na pyrophosphate (0.5%), cumin (1%) and starch (1%)) these ratios appears improved the nutritional value and sensory qualities of burger produced. No significant differences between formula (2) and formula (1) with compared control, formula (2) was the highest scores panelists, nutrition value and quality.

Table 7. Sensory evaluation of burger substituted with extruded wheat germ.

Panelists	Control	F_1	F_2	F_3	F_4	LSD
Color	17.93 $\pm1.44^a$	16.71 $\pm1.68^{ab}$	16.71 $\pm1.27^{ab}$	16.86 $\pm2.18^{ab}$	15.86 $\pm2.88^b$	1.4924
Taste	17.36 $\pm1.34^a$	15.29 $\pm2.16^b$	15.57 $\pm1.78^b$	14.14 $\pm2.28^{bc}$	13.14 $\pm1.70^c$	1.4228
Oder	17.64 $\pm1.78^a$	16.36 $\pm2.64^{ab}$	16.14 $\pm1.53^{ab}$	15.78 $\pm3.79^b$	15.29 $\pm2.43^b$	1.6784
Texture	16.86 $\pm1.35^a$	15.14 $\pm1.70^{ab}$	15.42 $\pm2.14^{ab}$	15.28 $\pm2.78^{ab}$	14.14 $\pm3.28^b$	1.5928
Overall acceptability	17.57 $\pm3.09^a$	15.86 $\pm1.43^b$	15.86 $\pm1.46^b$	15.43 $\pm1.41^b$	13.43 $\pm2.83^c$	1.2621
Total score	87.36	79.36	79.70	77.49	71.86	-------

Values are means for 10± SD. There is significant difference between the letters ($P >0.05$).

Conclusions

It can be using extruded wheat germ as replacement of part beef meat at different levels with maintain the quality attributes, Chemical, physical and sensory characteristics of beef burger.

From the obtained results, it can be recommended that the best replacement level in beef meat with extruded wheat germ was 10% F 2 ₍68% beef meat

and 10% extruded wheat germ). Where, F2 had the highest panelists scores.Chemical, physical and characteristics.

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استخدام جنين القمح فى اعداد البرجر

*محمود فرحات سيد قدوس –   **سعد عزيز محجوب –   **وليد محمد شحاتة

*قسم بحوث اللحوم والأسماك – **قسم بحوث تكنولوجيا المحاصيل

معهد بحوث تكنولوجيا الأغذية– مركز البحوث الزراعية – جيزة-مصر

الملخص العربي

تهدف هذه الدراسة إلى الاستفادة من جنين القمح المعامل بالبثق الحراري فى إنتاج برجر لحم. حيث كانت نسب استبدال جزء من اللحم البقرى بجنين القمح المعامل بالبثق الحرارى   (5 20,15,10%) . تم تقدير التركيب الكيماوي والخصائص الطبيعية والصفات الحسية للبرجر الناتج. حدث زيادة في نسب الكربوهيدرات والألياف ، والرماد بينما انخفضت نسب البروتين والزيت مع الزيادة في إضافة جنين القمح المعامل بالبثق الحراري. أيضا حدثت زيادة في نسب عناصر الماغنسيوم والبوتاسيوم والمنجنيز والزنك والفوسفور بينما انخفضت نسبه عناصر الصوديوم والحديد والكالسيوم في البرجر الناتج. استبدال جزء من اللحم البقرى بجنين القمح المعامل بالبثق الحراري   فى انتاج البرجر حسن خصائص الجودة الكيماوية والطبيعية للبرجر الناتج (TVN, TBA, pH, WHC and plasticity) وقد تحققت أفضل صفات الجودة عند نسبه 10% عند المقارنة بالكنترول. لذلك نوصى بإضافة جنين القمح المعامل بالبثق الحراري عند مستوى 10% للبرجر .