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UTILIZATION OF WHEAT PROTEINS AS A NUTRITIOUS, PRACTICAL MEAT SUBSTITUTE

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ABSTRACT

A low meat intake, especially red meat is recommended to avoid the risk of cancer, obesity and metabolic syndrome. So many of people move away a meat centered diet, but it is sometimes difficult to find interesting substitutes for meat.

In this study wheat gluten (seitan) and sweet lupine (ground whole seeds after socking in water for 12h. and boiling in water for 30 min.) were used as meat substitute for processing beefburger products.

Therefore, the following burger products were manufactured: Beefburger prepared with 100% beef (control); A sample prepared with 75% wheat gluten +25% sweet lupine; B sample prepared with 50% wheat gluten +50% sweet lupine; C sample prepared with 50%wheat gluten +25%sweet lupine +25% beef and D sample prepared with 50% wheat gluten +50% beef. These products immediately evaluated after processing.

Some chemical (moisture, fat, protein, ash, total carbohydrates and energy value) and cooking properties (cooking yield, cooking loss and shrinkage) were determined. Moreover, sensory evaluation and testing the significance among all burger products were carried out. In addition, the economic cost for each product was calculated.

Generally, the results indicated that all treatments A, B, C and D recorded lower moisture, fat, ash and higher protein content compared with control sample. Moreover, all treatments A, B, C, and D recorded higher cooking yield and lower cooking loss and shrinkage as well as lower cost when compared with the control sample. According to the results of sensory evaluation the treatment D (prepared with 50% seitan +50% beef) was the best among all the burger products followed by control sample, and there were nonsignificant differences (either at significant level of 0.05 or 0.01) between B and control sample or between control and C sample. Therefore, treatment B and C are suggested to produce a healthy beefburger with high quality and low cost.

INTRODUCTION

Meat is frequently associated with a" negative" health image due to its high fat content, and in the case of red meat is seen as cancer –promoting food .Therefore, a low meat intake ,especially red meat, is recommended to avoid the risk of cancer ,obesity and metabolic syndrome (Biesalski,2005). So, many of people moves away from a meat – centered diet, but it is sometimes difficult to find interesting substitutes for meat.

Among the non-meat additives tried as filler, binders & extenders are soya bean in beef patties (Miles *et al.*1984 and Ray *et al.*, 1981), faba bean, Lentils, Lupine and Chick peas in beef sausage (Abu Bark *et al.*1986), defatted sunflower meal in beef patties (Rossi,1988), wheat flour in chicken nuggets (Rao *et al* 1997) and cowpea and peanut flours in chicken nuggets (Prinyawiwatkul *et al.*1997)

Increasing interest is being shown in partial replacement of meat systems with extenders, binders and fillers in order to minimize the product coast while improving or at least maintaining nutritional and sensory qualities of end products that consumers expect. A new meat substitute is Seitan (Say-Than) a chewy, protein- rich food made from hard winter wheat that resembles texture and taste of meat. It is also, called wheat meat and known as seitan in Japan (The Japans word Seitan meaning is protein), as Kofu in China and as wheat meat and "Gluten" in the U.S.

Seitan a low fat, high protein, firm texture meat substitute .It is a rich flavor food important in tradition as well as for nutrition, (Jill Nussinow,1996).

One of dietary benefits of Seitan is low sodium content. Moreover, like grain foods in general, this protein is incomplete and needs to be complemented with other protein sources such as dairy or legumes (Jill Nussirow, 1996). The addition of sweet lupine to wheat flour –based products has the potential to increase dietary fiber content and improve protein content and quality (Petterson,1998). Unlike highly processed legume ingredients such as purified fiber and protein isolate, sweet lupine flour also provides a wide range of phytochemicals, including antioxidants and phytosterols, which may benefit health (Petterson, 1998). Regular consumption of legumes is promoted by health authorities in western countries as a means of reducing the diseases risks such as cancer, diabetes, and coronary heart disease (Leterne and Munoz, 2002). The objective of this study was to assess wheat protein as meat substitute. Also, evaluation the use of lupine as complementary protein to the wheat protein for processing burgers and employing untrained taste panel as consumers to the new burger products

MATERIALS AND METHODS

1-Deboned beef procured from the market was brought to the laboratory, washed with clean water, trimmable fat removed by knife and the meat minced.

2-Sweet lupine (Lupinus angustifolius) was bought from the local market and used after soaking in clear water for 12hr., then boiled for 30 min. after that ground whole to obtain seeds flour

3- Wheat Protein preparation According to Jill Nussinow (1996) sietan (wheat protein) can be prepared using whole –wheat flour. The flour is mixed with enough water to make into dough. The dough is then kneaded and rinsed under running water to remove the starch and the bran. The protein or gluten remains and is then simmered in a broth flavored with soy sauce and other spices to become seitan.The longer the gluten simmers the firm it becomes. For this point the gluten needs to be simmered in broth for at least 1 hour and up to 2 hours or more.

4-Processing of beefburger: The processing of beefburger was carried out in the laboratory of Meat and Fish Technology Res. Dept., Food Technology Res. Inst., Agric.Res. Center, Cairo. According to the traditional method. Five treatments of burger were prepared as follows:

1-100% beef (control).

2-(A) 75% wheat protein (gluten = sietan) +25% sweet lupine.
3-(B) 50% sietan + 50% sweet lupine.
4-(C) 50% sietan +25% sweet lupine + 25% beef.
5-(D) 50% sietan +50% beef.

Obtained meat was ground using a house mincer, and mixed with all ingredients (presented in table, 1) and shaped in circular burger form of 10 cm. diameter, 0.5cm thickness and about 60g.weight. Each piece was separated from the other using butter paper then packaged in polyethylene bags and frozen at -18 c before frying. Frozen stored burger samples were kept in deep freezer until analysis.

Table (1): Formulation of beef burger products.*

Ingredients	Control	A	B	C	D
Fresh beef	75%	-	-	18.75%	37.5%
Wheat gluten (Seitan)	-	50%	37.5%	37.5%	37.5%
Sweet lupine	-	25%	37.5%	18.75%	-
Fresh onion	6.5%	6.5%	6.5%	6.5%	6.5%
Powdered grits	10%	10%	10%	10%	%١٠
Whole eggs	6%	6%	6%	6%	6%
Salt	1.5%	1.5%	1.5%	1.5%	1.5%
Spice mixture	1%	1%	1%	1%	1%

***Control :(All beef); A:(sietan : sweet lupine ; 3:1);B:(sietan :sweet lupine ;1:1);C:(sietan :sweet lupine :beef ; 2:1:1) and D:(sietan :beef ;1:1).**
Protein sources in recipe is 75%.

5-Analytical Methods: Gross chemical composition was determined,i.e.,moisture content ,total protein (N x 6.25),total lipids and ash content ,according to the methods described in the A.O.A,C (1995). Carbohydrates content were calculated by difference. Cooking loss% of samples calculated as percentage of weight change from the raw to cooked state. Cooking yield and shrinkage were determined according to the equation given by Adams (1994).

6 –Organoleptic evaluation: Each cooked sample of the products was prepared to be tested organoleptically, according to the procedure reported by Watts, *et al* (1989). In this procedure, ten members of the Food section laboratory were asked to evaluate the taste, aroma, texture and the over all acceptability of the tested samples numerically as follows:
Very good 8-9, good 6-7, fair 4-5, poor 2-3 and very poor 0-1.

7-Statistical Analysis:
To find out the best product and testing the significance between all the products, ranking method and the critical values of differences among rank sums were used as described by Basker (1988).

RESULTS AND DISCUSSION

Proximate composition:

Composition of beefburger as affected by partial or total substitution of wheat gluten and sweet lupine instead of beef is presented in table (2). From the results(Table,2) it could be observed that substituting beef with wheat gluten and /or sweet lupine lead to increase in protein content while the moisture content of burger products decreased when compared with

control sample . The increase in protein content was by 12.6% -20.2 %, while the decrease in moisture content was by 0.19% -6.51% when calculated for treatments relative to control. The decrease of moisture in burger products might be expected due to the high protein and low moisture content for both wheat gluten and sweet lupine compared to beef .Besides, results in table (2) indicated that substitution of beef with wheat gluten and /or sweet lupine decreased fat content than in the control sample, the lowest fat content (4.1) was found in the sample A (containing 75%wheat gluten +25% sweet lupine). In contrast, the control had the highest fat content (6.7%), which might be expected because wheat gluten is extremely low fat protein (0.5% fat in its raw state), this is in accordance with findings of Jill Nussinow, (1996). Besides, ash content of the prepared burgers increased progressively as the level of beef increased in formula, whereas the control sample had the highest ash content (6.41%) while the sample B (prepared with 50% wheat gluten +50% sweet lupine)had the lowest ash content (5.06%).On the other hand, the control sample had the lowest carbohydrates content (1.35 %) followed by the sample D (prepared with 50% wheat gluten +50% beef)which had (1.7 5%), while other samples had a much higher carbohydrates content than the control or D sample. Besides, D sample had the lowest energy value 131.7K.cal. which seams to be mainly due to the decrease of the important energy sources ,the lipids in the wheat gluten and the other energy source ,carbohydrates in the beef whereas D sample prepared with 50% wheat gluten +50% beef

Table (2): Effect of substituting beef with wheat gluten and /or sweet lupine on the chemical composition of beefburgers.

Items	Control	A	B	C	D
Moisture%	67.24	63.13	63.86	63.72	67.11
Protein%	18.3	22	21.5	21.1	20.6
Fat %	6.7	4.1	5.2	4.95	4.7
Ash %	6.41	5.33	5.06	5.53	5.84
***Total carbohydrates%**	1.35	5.44	4.38	4.7	1.75
Energy value k.cal./100g	138.90	146.66	150.32	147.75	131.7

*** Total carbohydrates calculated by difference**

Cooking yield, cooking loss and shrinkage:

Data presented in table (3) show the effect of substituting beef with wheat gluten and sweet lupine on the cooking properties of beefburgers. From these results (Table3) it could be observed that substituting beef with both of wheat gluten and /or sweet lupine lead to increase in cooking yield and decrease cooking loss of burger products .Besides, cooking yield was improved by increasing addition level of wheat gluten and sweet lupine, this improvement might be due to protein ability to bind fat which could reduce the anticipated losses of fat during cooking. The control sample had the lowest cooking yield (84%), while C sample had the highest (110%). The high losses in control beerburger might be attributed to the excessive fat separation and water release during cooking. Similar results were obtained by Troutt *etal*, (1992). On the other hand, control beefburger showed greater reduction in diameter (greater shrinkage) 8.05% by cooking as compared to the other

sample. This result was expected due to fat separation and water release during cooking. While, A sample had the lowest shrinkage 0% .This, result might be due to the low fat content of wheat gluten (0.5%) which leads to less fat separation during cooking. In addition, B, C and D samples had lower shrinkage than the control sample but higher shrinkage than A sample.

Table (3):Effect of substituting beef with wheat gluten and sweet lupine on cooking properties of beefburgers (%)

Parameters	Control	A	B	C	D
Cooking yield	84	88	100	110	94
Cooking loss	16	12	·	-10	٦
Shrinkage	8.05	0	3.3	4.4	6.7

Organoleptic evaluation of beef burger:

Organoleptic properties should be considered as important and essential factors in the palatability and consequently the acceptability of any food product .In this respect all of beefburger samples, either control without additives, or with both of wheat gluten and/or sweet lupine, were judged by twenty panelists after frying for their color, taste, aroma, texture and overall acceptability. The ranking method was used to arrange the accepted products according to their organoleptic quality. Data presented in table (4) show the mean score values of color , taste , aroma, texture and overall acceptability perceived for fried beef burgers, from which it was clear that as the percent of beef increased in the formula, mean scores of aroma increased. On the other hand the incorporation of sweet lupine favored the color of burgers .Meanwhile, some objection to texture and taste was noted when the formula of burger depended on the plant protein only ,whereas ,sample A had no firmness in texture and sample B had vegetable taste. Generally, the incorporation of wheat gluten and sweet lupine up to 50% in formula gave both good functional properties and very acceptable product.

Table (4): Mean values of organoleptic scores for fried beefburger products as affected by substituting beef with wheat gluten and sweet lupine.

Quality attributes	Control	A	B	C	D
Color	8.5	7.5	8	8.2	8.6
Taste	8.6	5	6	8	9
Aroma	8.7	5	6	8	8.6
Texture	8.4	3	5	7.5	9
Overall acceptability	8.55	5.13	6.25	7.93	8.8

Data presented in table (5) show the results of ranking method and critical difference, used to fined out the best product and testing the significance among all burger samples as affected by complete or partial substituting of beef with wheat gluten (seitan) and sweet lupine .According to the ranking method, the lowest sum of ranks means the best sample .From the results it could be observed that the best sample among all burgers was recorded for D (prepared with 50% seitan +50% beef) followed by control (100% beef) ,C (50%.seitan +25% sweet lupine +25% beef), B (50%seitan

+50% sweet lupine) and A (75% seitan +25 % sweet lupine). It is clear that D sample evidently recorded the lowest sum (30) of ranks among all the burger products .In addition, according to critical differences at significance level of 0.05 and 0.01 nonsignificant differences between D and control sample was recorded. This indicated the replacement of beef with 50% of wheat protein (gluten or seitan) was accepted and successful. Also, nonsignificant differences between C and control sample was noticed at significant level of 0.05 and between D and C at significant level 0.01 , this is mean capable of substituting beef with vegetable protein up to 75% percent (50% wheat protein +25% sweet lupine).

Table (5): Results of ranking method and critical values of burger products as affected by substituting beef with wheat gluten and sweet lupine.

Items**	Burger products*				
	Control	A	B	C	D
Sum of ranks	32	96	88	59	30
Difference Vs: Control	-	64	56	27	2
A	-	-	8	37	66
B	-	-	-	29	58
C	-	-	-	-	29
Significance level	P= 0.05		P= 0.01		
Critical difference	27.3		32.5		
Descending order of samples preferred:					
D Control	a		a		
C	ab		ab		
B	bc		Abc		
A	cd		cd		
	d		d		

*For explanation, see table (1) .

** The lowest sum of ranks means the best sample . ** Samples that have the same letters in the same column are not significantly different. ** When the differences between the sums of ranks of samples are greater than or equal to the critical difference, the significance level is attained.

However, either at significant level of 0.05 or 0.01 significant differences between D and B, A samples were recorded. Therefore, the D and C samples are suggested to produce healthy burger and overcome the problems resulted in consuming red meat.

Economic costs:

Data presented in table (6) indicate the cost (Egyptian pound/kg) of beefburger as affected by substituting beef with vegetable protein(wheat gluten and sweet lupine).From the results it could be observed that the costs were 19.25 ,5.25 ,5.00, 8.75 and 12.25 Egyptian pound per kg of control ,A ,B ,C and D burgers respectively .This indicated that substituting of beef with vegetable protein used in this study (either wheat protein and /or sweet lupine) reduced the costs of burger products when compared to control (prepared with beef only). This reduction of cost is due to using vegetable protein which has lower cost compared to beef. On the other hand , when comparing burger products with control sample the percent decrease of costs was 72.72% ,74.03% , 54.55% and 36.36% for A,B ,C and D respectively .

Overall, D and C samples are suggested to produce a healthier burger with high quality and lower cost.

Table (6): Cost (Egyptian pound /kg) of beefburger as affected by substituting beef with wheat gluten and sweet lupine.

Items	Burger products				
	Control	A	B	C	D
Cost (Pound /kg)	19.25	5.25	5.00	8.75	12.25
Decrease of cost compared to control	-	14	14.25	10.50	7.00
%Decrease of cost	-	72.72	74.03	54.55	36.36

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استخدام بروتين القمح كبديل (عملى ومغذى) للحم

شادية محمود شرف

قسم بحوث تكنولوجيا اللحوم و الأسماك- معهد بحوث تكنولوجيا الأغذية مركز البحوث الزراعية - القاهرة

لقد أصبح ضروريا" لتجنب الاصابة ببعض الأمراض مثل السرطان و أمراض القلب و السمنة الاقلال من استهلاك اللحوم الحمراء وخصوصا" المصنعة ولكن هناك صعوبة فى ايجاد البديل المناسب للحم للخفض من استهلاكه ولو عن طريق تقليل النسبة الداخلة منه فى مصنعات اللحوم . وبالرغم من وجود بعض البدائل المستعملة فعلا" الا انها قد تعطى قوام غير مرغوب أو رائحة نباتية. لذلك من المهم البحث عن بدائل جديدة.

وفى هذه الدراسة تم استخدام بروتين القمح (جلوتين) وكذلك الترمس الحلو (بعد نقعه لمدة ١٢ ساعة وسلقه لمدة 30دقيقة وفرمه بالقشرة للاستفادة بالقشرة كألياف غذائية) واستخدام الترمس مع بروتين القمح لزيادة جودة البروتين ، حيث نحصل من خلال الاثنين على بروتين شبه كامل يماثل بروتين اللحم فى القيمة الغذائية .

وقد استخدم جلوتين القمح والترمس فى عمل خلطات البرجر البقرى على النحو التالى :

- عينة مقارنة (كنترول) ١٠٠% لحم بقرى .
- عينة A (تحتوى على ٧٥% جلوتين +٢٥% ترمس) .
- عينة B (تحتوى على ٥٠% جلوتين + ٥٠ % ترمس) .
- عينة C (تحتوى على ٥٠% جلوتين + ٢٥% ترمس +٢٥ % لحم بقرى) .
- عينة D (تحتوى على ٥٠ % جلوتين +٥٠ % لحم بقرى).

وقد تم تقدير التركيب الكيماوى (رطوبة – دهن – بروتين – رماد – كربوهيدرات) وكذلك بعض خصائص الطهى (الناتج بالطهى – الفاقد – بالطهى – الانكماش) لجميع المنتجات عقب عملية التصنيع مباشرة". كما تم تقيم المنتجات حسيا" وكذلك تحليل قيم التقيم الحسى احصائيا" لايجاد افضل عينة ، ثم تم تقدير التكلفة الاقتصادية لجميع المنتجات.

وقد وجد أن العينات A,B,C,D كانت أقل فى محتوى الرطوبة و الدهن والرماد وأعلى فى محتوى البروتين مقارنة بعينة الكنترول .

وطبقا" للتقيم الحسى أوضحت النتائج أن العينة D كانت أفضل العينات يليها عينة الكنترول ثم العينة C وكانت العينة B مقبولة بينما كانت العينة A مقبولة الطعم ولكنها كانت مفككة القوام .

ولم يوجد فروق معنوية سواء على مستوى معنوى ٠,٠١ أو ٠,٠٥ بين العينة D وعينة الكنترول ، وكذلك بين عينة الكنترول والعينة C .

ومن حيث التكلفة الاقتصادية فقد أدى استخدام التوليفات المختلفة لتصنيع البرجر الى خفض التكلفة بنسبة تراوحت بين ٣٦,٤% - ٧٢,٥% عن عينة الكنترول

ولذلك يقترح استخدام كل من العينة C,D للانتاج البرجر البقرى للحصول على منتج صحى ذوقابلية تذوق عالية وتكلفة أقل.