Annals Agric. Sci., Ain Shams Univ., Cairo, 49(2), 571-584, 2004

PHYSICOCHEMICAL, BIOLOGICAL AND SENSORY EVALUATION OF COOKIES FORTIFIED WITH PROTEIN FROM DEFATTED PEACH KERNEL MEAL

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ABSTRACT

Physicochemical properties, sensory and biological assessment of cookies fortified with protein from defatted peach kernel meal (DPKM) at levels of 5, 10 and 15% and unfortified cookies (manufactured with wheat flour 72% extraction) were investigated as well as chemical composition of both wheat flour 72% extraction and DPKM was also undertaken. Results showed that, cookies fortified with DPKM were higher in moisture content, protein, fat, ash and fiber but lower in total charbohydrate influenced by ratio of fortification. The farinogram data indicated that, water absorption, the arrival time and dough development time were markedly increased with increasing the replacement ratios of DPKM. However extensograph data showed that, the higher proportional levels of DPKM replacement caused a gradual reduction in dough energy and dough stability but the resistance to extension was increased gradually. On the other hand, biological evaluation indicated that, fortification of cookies with 10 and 15% DPKM improved Feed Efficiency Ratio, Net Protein Utilization, Digestibility Coefficient, Biological Value and Protein Efficiency Ratio, while cookies fortified with 5% DPKM recorded the highest and the best criterion of sensory evaluation followed by cookies fortified with 10 and 15% respectively.

Key words: Defatted peach kernel meal (DPKM), Cookies (Biscuits), Farinograph, Extensograph, Sensory evaluation, Biological evaluation.

INTRODUCTION

In developing countries cereals are the principal energy and protein sources in the diet. Lack of adequate food and in particular high quality protein primary cause malnutrition in children which causes retarded growth (Wyatt *et al* 2001). Dietary Reference Intakes (DRI) for protein on day estimated by 9.1- 13.5 gm for infants, 13-19 gm for children, 34-56 gm for males, 34-46 gm for females, 59-71 gm for pregnancy and lactation Sylvia (2002).

Protein is the most important macronutrient need. The proteins provide the amino acids which are needed to synthesize the body protein. Protein, in its many

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(Received September 22, 2004)
(Accepted October 4, 2004)

forms, is an essential and universal constituent of all living cells. As much as one half of the dry weight of the cell in protein. The human body on the average is 18% protein. Besides being plentiful, proteins serve variety of functions. They serve as structural components, biocatalysts (in the form of enzymes), as antibodies, as lubricants, as messengers (in the form of hormones), and as carriers. Proteins are compared of amino acids which must be provided in food. After digestion the amino acids which comprise the food proteins are absorbed and used to synthesize body proteins (**Tsuda *et al* 2003**).

In order to minimize the amounts of imported wheat especially its world price is annually increasing, to utilize from high amounts of industrial wastes to produce beneficial products which able to use as a substitution or fortifiers of food products. More over, the great challenges today is to develop inexpensive baked foods that are of high quality, nutritionally superior and being acceptable to the intended consumers (**Abel Hamid *et al* 2002**).

Galal (1992) mentioned that Defatted Peach Kernels flour contained 60.06% protein, free from hydrocyanic acid (HCN) and the major amino acid was glutamic acid (29.85%). On the other hand, **Lee (1988)** found that, the predominant amino acid in Peach Kernel was argenine, followed by glutamic acid and then aspartic acid.

He and Haseney (1992) studied the effect of flour protein content on dough expansion and rate of Co_2 loss from dough during baking and extended proofing.

Defatted Peach Kernels Meal is a good source of most amino acids important for humans nutrition and by blending it with other vegetable protein materials will produce well balanced diets, moreover Defatted Peach Kernels Meal is a rich source for some minerals such as potassium, calcium, phosphorus and magnesium (**Rahma and Abd El-Aal, 1988**).

Therefore, the present investigation was undertaken to evaluate the effect of using Defatted Peach Kernel meal to replace of wheat flour at different levels on chemical composition, rheological properties, sensory evaluation and biological assessment to produce high protein cookies.

MATERIAL AND METHODS

Materials

Peach fruits *(Prumus persica)* were obtained from local market season 2003 and wheat flour (72% extraction) was obtained from Egyptian Millers Company, Giza, Egypt.

Methods

1- Preparation of Defatted Peach Kernel Meal (DPKM)

The pits were removed from the tissues by hand, washed with water and sun dried for 3 weeks. The dried pits were crushed by manual cracking. The kernels were boiled for 30 min. in sodium bicarbonate 0.1%, then soaked for 48 hr. in distilled water to remove bitterness (detoxification) and shelled (brown skin) after that, dried at 50°C in a forced draught air oven. The peach kernels were ground to pass through a 70 mesh sieve to get kernels meal, lipids were extracted by

n-hexane in a Soxhlet apparatus for 24 hr. and the defatted meal was air dried at room temperature and used to replace of wheat flour 72% extraction at different levels.

2- Manufacturing of cookies

The method described by **Sanchez *et al*** (1995) was used for manufacturing of cookies. The basal cookies dough (control) was consisted of 100 gm wheat flour (72% extraction), 29.9 gm sugar, 32.5 gm hydrogenated vegetable oil, 0.17 g ammonium bicarbonate, 1.04 gm sodium bicarbonate, 0.17 gm cream of tartar, 0.1 gm vanillin crystals, 1.5 gm salt and 7.49 gm water. Defatted Peach Kernel Meal (DPKM) was replaced to wheat flour at levels of 5,10 and 15%, respectively.

3- Chemical analysis

Moisture, protein, fat, crude fiber, ash and hydrocyanic acid (HCN) for wheat flour (72% extraction), Defatted Peach Kernel Meal and cookies were determined according to the methods described in AOAC (1995).

4- Farinograph and extensograph tests

Farinograph and extensograph tests for wheat flour 72% extraction and its mixtures with different levels of Defatted Peach Kernel Meal were carried out according to **(AACC method, 1993).**

5-Biological experiment

Forty eight female weanling albino rats average weight 45-50gm were divided randomly into six groups of rats, each group contained eight rats. The first group was fed on protein free diet, the second group fed on casein as a basal (control) and other groups were fed on four tested diets for 30 days as shown in Table (1). Feeding was continued for 30 days, during which each rat was weighted at the beging of experimental period and after 10 days intervals. At the end of experimental (30 days) rats were sacrificed with chloroform. The carcasses were dried in oven at 105°C for 48h. then ground. Nitrogen content of the carcasses, feed Nitrogen intake and feces nitrogen were determined by macro-Kjeldahl method according the method of *AOAC (1995)*. Net Protein Utilization (NPU), Digestibility Coefficient (DC) and Biological Value (BV) were estimated using the following equations as described by ***Bender and Miller (1955).***

$$N.P.U = \frac{B_n - B_k}{I} X\ 100$$

$$D.C = \frac{I - (F - F_F)}{I} X\ 100$$

$$B.V = \frac{NPU}{DC} X\ 100$$

Where:

Bn = Body nitrogen of rats fed on the tested protein.

BK = Body nitrogen of rats fed on the protein free diet.

I = Nitrogen intake during the experimental period.

F = Fecal nitrogen value of the rats fed on the protein diet.

Ff = Fecal nitrogen value of the rats fed on the protein free diet.

Ratio (PER) was calculated as the equation described by **Bender and Doell (1957).**

Table 1. Composition of basal (control) and tested diets (g/100g).

Ingredients	Free protein diet	Control diet	Group No. 1	Group No. 2	Group No.3	Group No. 4
Casein		11.30				
Control cookies (100% wheat flour)			86.15			
Cookies fortified with 5% DPKM				77.18		
Cookies fortified with 10% DPKM					69.4	
Cookies fortified with 15% DPKM						62.31
Corn oil	12.17	12.17	3.30	3.02	2.55	2.10
Salt mixture	4.0	4.0	4.0	4.0	4.0	4.0
Vitamin mixture	1.0	1.0	1.0	1.0	1.0	1.0
Starch	82.83	71.53	5.55	14.80	23.05	30.59
Total	100	100	100	100	100	100

DPKM = Defatted Peach Kernel Meal.

$$PEC = \frac{Gain\ body\ weight\ (gm)}{Protien\ cassumed\ (gm)}$$

6- Sensory evaluation of cookies

Ten panelists were asked to evaluate color, texture, taste, flavor and over all acceptability according to the method of *Claughton and Pearce (1989).*

7- Statistical analysis

The obtained data in this research has been statistically analyzed using the statistical analysis system SAS (1988).

RESULTS AND DISCUSSION

Chemical composition of wheat flour and Defatted Peach Kernel Meal

Chemical composition of wheat flour and defatted Peach Kernel Meal are presented in Table (2). Results indicated that Defatted Peach Kernel Meal (DPKM) was higher in protein content (48.12%) compared with wheat flour (11.87%). These results are in accordance with those obtained by **El-Adawy and El-Kadousy (1995).**

Table 2. Chemical composition of wheat flour (72% extraction) and Defatted peach Kernel Meal (on dry weight basis)*

Tested samples	Moisture	Protein	Fat	Ash	Crude fiber	Total carbohydrates**	Hydrocyanic acid
Wheat flour (72%)	10.83	10.87	1.17	0.52	0.88	86.56	ND
Defatted Peach Kernel Meal	4.92	48.12	2.88	2.20	3.89	42.91	ND

* All values are mean of triplicate determination.
** Calculated by difference.
ND = Not detected.

On the other hand, the ash content in DPKM (2.2%) was higher than wheat flour 72% extraction 0.52%. Meanwhile, from the same table, it could be observed that, DPKM was free from hydrocyanic acid. These results coincide with **Galal (1992)** who mentioned that, defatted flour produced from peach kernels was free from HCN.

Chemical composition of unfortified and fortified cookies made with different levels of Defatted Peach Kernel Meal (DPKM)

The changes in chemical composition of cookies prepared from wheat flour replaced with Defatted Peach Kernel Meal at different levels of 5,10 and 15% compared to control cookies prepared with 100% wheat flour, are given in Table (3). It could be noticed that, moisture content of cookies prepared with different levels of DPKM, markedly and gradually increased as the substitution level increased having the values of 6.37, 6.60 and 6.93% at levels of 5,10 and 15% DPKM, respectively, compared to 5.98% in control sample. The increases in moisture content in substituted samples may be due to the higher fiber content which absorb and retain more water. A gradual increase was also noticed in protein, fat, ash and crude fiber as the substitution level increased. On contrary, results indicated also a gradual decreases in total carbohydrate with increasing of DPKM levels. This finding was in agreement with **Haruthaithanason and Sinthavalai (1992)**. Therefore the higher levels of DPKM, caused an increas in moisture, protein, fat, ash and crude fiber in the resultant cookies.

Rheological properties of unfortified and fortified cookies

A farinograph curve gives two important physical properties of flour: water absorption, the amount of water required for a dough to reach a defined consistency and a general profile of the mixing behavior, mixing time, mixing stability of the dough **(D'Appolania, 1984)**. Farinograph data of wheat flour (control) and % replacement ratios of Defatted Peach Kernel Meal are shown in Table (4). The water absorption increased gradually by

Table 3. Chemical composition of cookies made with different levels of Defatted Peach Kernel Meal (DPKM) (on dry weight basis)*

Cookies types	Moisture	Protein	Fat	Ash	Crude fiber	Total carbo-hydrates**
Unfortified (control)	5.98	12.0	1.20	0.61	0.92	85.27
Fortified with 5% DPKM	6.37	14.52	1.26	0.70	1.08	82.44
Fortified with 10% DPKM	6.60	16.78	1.31	0.82	1.15	79.94
Fortified with 15% DPKM	6.93	19.94	1.39	1.03	1.24	75.40

* All values are mean of triplicate determination.
** Calculated by difference.

Table 4. Rheological properties of wheat flour substituted with different levels of Defatted Peach Kernel Meal (DPKM).

Rheological data	Substitution levels			
	0	5	10	15
Farinagraph data:				
Water absorption (%)	55.2	58.9	60.3	62.1
Arrival time (min)	1.5	2.0	2.5	3.0
Dough development (min)	2.5	2.5	3.0	4.0
Dough stability (min)	7.5	7.0	6.5	6.0
Degree of weakening (B.U.)	45	50	60	65
Extensograph data:				
Dough energy (cm^2)	120.2	117.5	112.1	103.0
Dough extensibility (mm)	210.0	205.0	195.0	190
Resistance to extension (B.U.)	410	520	560	780
Proportional number (R/E)	1.95	2.53	2.87	3.05

B.U. = Brabender unit
R/E = Resistance / Extensibility

increasing the replacement ratios recording 58.9, 60.3 and 62.1 for replacing with 5,10 and 15%, respectively comparing with control 55.2%. The higher water absorption of wheat flour blends with different ratios of Defatted Peach Kernel Meal may be due to the increased hydration capacity of protein (**El-Adawy, 1995 and Rasco *et al* 1990**). The arrival time and dough development time were markedly increased with increasing the % replacement ratios of Defatted Peach Kernel Meal than control samples. The increase in dough development time may be due to the differences in physicochemical properties of Defatted Peach Kernel Meal and that of wheat flour. These findings were observed by **El-Adawy, (1995)** for different protein source.

Dough stability time (min) as a major index for dough strength indicated that, selected replacement ratios of DPKM reduced the stability periods for all tested replacement ratios compared to control. These results agree well with **Anjum *et al* (1991) and El-Adawy (1995)**. They found that, the high level of substitution of sunflower protein concentrate and isolate and wheat flour supplemented with sesame products at protein levels of 14, 16, 18 and 20% may be responsible for decreasing the dough stability time. On the other hand, the degree of weakening showed a gradual increases form 45 B.U. for wheat flour dough reaching to 50, 60 and 65 B.U., respectively for 5, 10 and 15% replacement by DPKM, respectively. These results are similar with **Bajwa (1997)** who reported that, addition of 10% defatted soy meal increased water absorption, dough developing time, mixing tolerance index and dough stability.

The extensograph data in Table (4) showed that, replacement of wheat flour with DPKM at levels of 5, 10 and 15% caused a gradual reduction in dough energy and dough extensibility. These clear decreases might be due to the absence of gluten in Defatted Peach Kernel Meal. These findings agree with **El-Farra *et al* (1982) and Yassen & Ibrahem (1997)**. Meanwhile, the resistance to extension (elasticity) upon replacing with different ratios of DPKM increased gradually being of 410, 520, 560 and 580 B.U. for wheat dough (control, 5, 10 and 15%) replacement of dough with DPKM, respectively. On the other hand, the values of proportional number showed ascending order with enhancing of the values of DPKM, it was from 1.95 to 3.05 R/E in wheat flour dough and wheat flour dough replaced with 15% DPKM, respectively. It is worth noting that one cannot exclude the possibility that extensograms reflect the differences among flours under mixing conditions rather than under streching conditions. **Pomeranz (1988)** reported that extensibility of dough depends on the presence of sufficient glutamines with a high molecular weight. Disulfide bonds link the glutenin in subunits together, which explains the effect of oxidation and reduction on the distribution of molecular weights and on rheological properties of dough.

Biological evaluation

Effect of tested diets on food intake, body Weight gain, Body nitrogen, nitrogen intake and fecal nitrogen

By the end of the experimental rats, animals fed on the cookies fortified with different ratios of Defatted Peach Kernel

Meal had lower feed intake than animals fed on the control diet, but higher than that fed the diet free from protein, but the differences were significant in all cases (Table 5). Body weight gains was not significantly different for animals fed on cookies fortified with 15% DPKM and control. However, statistical analysis showed that diet free from protein was more effective on the reduction of final body weight gain of rats at the end of experiment followed by unfortified cookies, cookies contained 5, 10 and 15% DPKM, respectively. On the other hand, rats fed on 5, 10 and 15% DPKM, recorded higher body nitrogen compared with those fed on diet free from protein, but there was no difference in body nitrogen between rats fed on 15% DPKM and control diet. Since, there were no difference in nitrogen intake between rats fed on 10, 15% DPKM and control diet. From the same table, it could be observed that, there were no significant difference in fecal nitrogen between rats fed on unfortified cookies, and both cookies fortified with 5 and 10% DPKM. Meanwhile, a significantly difference in fecal nitrogen for rats fed on control diet and all tested treatments at the end of experiment were observed. Therefore, the higher food intake, body weight gain, body nitrogen and nitrogen intake correlated well with cookies fortified with 15% DPKM followed by cookies fortified with 10 and 5% DPKM, respectively.

Table 5. Effect of cookies fortified with different levels of Defatted Peach Kernel Meal on food intake, body weight gain, body nitrogen, nitrogen intake and fecal nitrogen in feed rats for 30 days*.

Diet content	Food intake (g)	Body Weight gain (g)	Body nitrogen (g)	Nitrogen intake (g)	Fecal nitrogen (g)
Control (casein)	206 a	48 a	9.23 a	5.58 a	0.54 c
Diet free from protein	141 e	23 d	4.82 e	-	0.20 d
Unfortified cookies	149 d	27 c	6.76 d	3.28 c	0.79 a
Cookies fortified with 5% DPKM	163 c	33 b	7.36 c	4.02 b	0.78 a
Cookies fortified with 10% DPKM	188 b	43 b	8.51 b	5.20 a	0.74 a
Cookies fortified with 15% DPKM	201 a	47 a	8.97 a	5.53 a	0.68 b
L.S D. (0.05)	1.23	0.39	0.62	0.29	0.07

* Values within column followed by the same letter are not significantly different (P> 0.05).

Effect of tested diets on FER, NPU, DC and BV.

Table (6) represented the effect of tested diets on FER, NPU, DC and B.V. There were no significant differences in FER occurred between rat groups fed on control diet versus cookies fortified with 5, 10 and 15% DPKM. Net protein utilization, Digestibility Coefficient and Biological values were similar for rats fed on the cookies fortified with 15% DPKM and control diet. Thereafter, the mean values of FER, NPU, DC and B.V. for rat groups fed on cookies prepared with whole wheat flour, and cookies fortified with 5, 10 and 15% DPKM, showed significant decreases as the replacement of DPKM decreased compared to the control diet. Therefore the mean values of FER, NPU, DC and B.V. slightly and gradually increased versus increased with fortified DPKM on experimental rat diets. These results are in correspondence which those obtained by **El-Adawy and El-Kadousy (1995).** They showed that DPKM an increase-vitro protein digestibility and biological values. They added also that the increase in biological values was attributed to the increase in essential amino acid levels. Furthermore they proved that DPKM showed an increase in non polar amino acids, polar amino acids, basic amino acids, sulphure amino acids, aromatic amino acids and essential amino acids.

Table 6. Effect of cookies fortified with different levels of Defatted Peach Kernel Meal on Feed Efficiency Ratio (FER), Net protein utilization (NPU), Digestibility Coefficient (DC) and Biological Value (BV) in feed rats for 30 days*.

Diet content	FER	NPU (%)	DC (%)	BV (%)
Control (casein)	0.23a	78.96a	98.80a	84.17a
Cookies (unfortified)	0.18b	59.12d	82.03c	72.07c
Cookies fortified with 5% DPKM	0.20a	63.26c	85.45b	74.03c
Cookies fortified with 10% DPKM	0.21a	70.94b	89.51b	79.25b
Cookies fortified with 15% DPKM	0.23a	74.92a	91.18a	82.16a
L.S.D. (0.05)	0.31	1.15	1.79	1.60

* Values within column followed by the same letter are not significantly different (P>0.05).

Effect of tested diets on body weight gain, food consumed, protein consumed and Protein Efficiency Ratio (PER).

From Table (7), it could be noticed that, body weight gain, food consumed, protein consumed and PER were not significantly different for cookies fortified with 15% DPKM versus control diet. Unfortified cookies and cookies fortified with 5% DPKM were the least values of rats body weight gain, food consumed and protein consumed. Overall body weight gains of rats showed a significant inverse relationship with the DPKM level. No significant difference was found for food consumed, protein consumed and PER for rat groups fed on control diet and cookies fortified with 5 and 10% DPKM. However body weight gain, food consumed, protein consumed and protein efficiency ratio for rat groups fed on tested diets tended to increase as the level of DPKM in the diets increased.

Therefore, fortification of cookies with 10 and 15% Defatted Peach Kernel Meal tented to improve Feed Efficiency Ratio (FER), Net Protein Utilization (NPU), Digestibility Coefficient (DC), Biological Value (BV) and Protein Efficiency Ratio (PER). Hence, DPKM as a protein source might play roles in fortified cookies.

Table 7. Effect of cookies fortified with different levels of Defatted Peach Kernel Meal on body weight gain, food consumed, protein consumed and Protein Efficiency Ratio (PER) in feed rats for 30 days*.

Diet content	Body weight gain (gm)	Food consumed (gm)	Protein consumed (gm)	PER
Diet control (casein)	56a	234a	25.8a	2.51a
Cookies (unfortified)	35c	209c	20.9b	1.67b
Cookies fortified with 5% DPKM	42b	216b	21.0b	2.00a
Cookies fortified with 10% DPKM	46b	224a	22.6a	2.03a
Cookies fortified with 15% DPKM	51a	229a	24.2a	2.10a
L.S.D. (0.05)	1.57	4.12	1.03	0.80

* Values within column followed by the same letter are not significantly different (P>0.05).

Sensory evaluation

Sensory evaluation is considered as an important indicator of potential consumer preferences. Inspite of its short comings it will remain one of the most reliable quality assessment technique for food and food products in general, and for bread and bakery products in particular. Mean values of sensory scores of unfortified (control) cookies and fortified cookies with 5, 10 and 15% Defatted Peach Kernel Meal are shown in Table (8). The color of different samples showed no significant difference between control cookies and both cookies fortified with 5 and 10% DPKM. while, slightly difference was observed for cookies fortified with 15% DPKM and other tested samples. Consequently, the mean values of texture, taste, flavor and over all acceptability scores for unfortified and fortified cookies with 5% DPKM observed that no difference between them. However, the highest mean score values for texture and color were received for control cookies followed by cookies fortified with 5, 10 and 15% DPKM respectively. Meanwhile, the lowest mean score for color values were received.

Cookies made with 15% DPKM. Since, there are no difference in over all acceptability in cookies fortified with 5% Defatted Peach Kernel Meal compared with unfortified cookies. Foreinstance, Panelists could not differentiate between both unfortified cookies and cookies fortified with 5% DPKM. Therefore, cookies fortified with 5% DPKM recorded the highest and the best scores for tested criterion of sensory evaluation followed by cookies fortified with 10 and 15% DPKM, respectively.

Table 8. Sensory characterisics scores of unfortified and fortified cookies made with different levels of defatted peach meal (DPKM)

Cookies type	Color (20)	Texture (20)	Taste (20)	Flavor (20)	Over all acceptability (20)
Control	19.1a	18.6a	18.8a	19.1 a	19.0a
Fortified with 5% DPKM	18.9a	18.0a	18.4a	19.0 a	19.0a
Fortified with 10% DPKM	18.4a	17.8ab	18.1ab	18.5 b	18.8a
Fortified with 15% DPKM	18.0b	17.3 b	17.9 b	18.1 b	18.5b
L.S.D. (0.05)	0.78	0.74	0.77	0.82	0.84

Values within column followed by the same letter are not significant different (P>0.05).

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مجلة حوليات العلوم الزراعية، كلية الزراعة ، جامعة عين شمس ، القاهرة ، م(٤٩)، ع (٢)، ٥٧١-٥٨٤، ٢٠٠٤

التقييم الطبيعى والكيماوى والبيولوجى والحسى للبسكويت المدعوم ببروتين نوى الخوخ الخالى من الدهن

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أجريت هذه الدراسة بغرض دراسة مدى تأثير تصنيع البسكويت المـــدعوم ببـــروتين نوى الخوخ المنزوع الدهن بنسب اســـتبدال ٥، ١٠، ١٥% والعينة الضـــابطة (١٠٠% دقيق قمح استخلاص ٧٢%) على الخواص الطبيعية والكيماوية والريولوجيـــة والتقيـــيم البيولوجى والحسى للعينات المصنعة. هـــذا ولقد أخذ فى الاعتبار أيضاً دراسة التركيب الكيماوى لكلا من دقيق القمـــح اســـتخلاص ٧٢% وكذلك مستخلص نوى الخوخ منزوع الدهن ولقد أوضحت الدراسة أن البســـكويت المدعوم بمستخلص نوى الخـــوخ منـــزوع الدهن كان مرتفعاً فى محتواه من الرطوبة، البروتين، الدهن، الرماد والألياف ولكن كان

منخفضاً فى محتواه من الكربوهيدرات الكلية ومن النتائج المتحصل عليها من الفارينوجراف اتضح أن زيادة نسب الاستبدال بمستخلص نوى الخوخ المنزوع الدهن بالدقيق أدى إلى زيادة نسبة امتصاص الماء، زمن الوصول، فترة تكوين العجينة، ولقد أشارت النتائج المتحصل عليها من جهاز الأكستنسوجراف أن زيادة نسب الاستبدال بمستخلص نوى الخوخ المنزوع الدهن أدت إلى حدوث انخفاض تدريجى فى الطاقة (المساحة تحت المنحنى)، ثبات العجينة مع حدوث زيادة فى المقاومة للشد.

ومن ناحية أخرى فلقد لوحظ من التقييم البيولوجى باستخدام فئران التجارب إلى أن زيادة نسب الاستبدال أدت إلى حدوث تحسن فى نسبة فاعلية الوجبة وصافى الاستفادة من البروتين ومعامل الهضم والقيمة البيولوجية ونسبة كفاءة البروتين.

هذا ولقد أوضحت نتائج التقييم الحسى أن البسكويت المدعوم بـ ٥% مستخلص نوى الخوخ المنزوع الدهن سجل أعلى درجات للتقييم الحسى تلاه المدعوم بـ ١٠% ثم ١٥% على التوالى.

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