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UTILIZATION OF WHEAT GERM IN SOME FOOD PRODUCTS

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ABSTRACT

The present study was carried out to evaluate the wheat germ which is available as by-product of mills and utilize it in some food products. The cookies obtained with 10% toasted wheat germ (TWG) replacement was organoleptically similar to the control. Substitution level of 15% TWG resulted in rejection of cookies, mainly because of its flavor. Beef burgers of the control, 5% and 10% wheat germ were considered acceptable. Substitution level of 15% TWG significantly decreased the overall palatability of beef burger. Addition of 10% whole wheat germ in beef burger decreased the percentage of fat loss (18%) and shrinkage (21.68%) compared with control (18.3% and 26.04% respectively).The percentage of cooking and moisture losses were 17.85% and 24.09% for the sample which contain 10% wheat germ, respectively while it was 17.22% and 23.1% for counterpart of the control. At the level of 3% whole wheat germ addition of mayonnaise, the product was organoleptically, similar to control, while the increasing of addition level at (6%) affected on texture of mayonnaise. The percentage of mayonnaise acidity (as acetic) was 2.44 (control) and 3.11% (12% TWG sample), while the pH value ranged between 4.02 and 4.29. No significant difference was observed in emulsion stability between control and 3% TWG sample. The color measured by Lovibond tintometer varied from light yellow to dark yellow, the addition of wheat germ increased red color by 2 or 3-fold, while less effected on value of yellow or blue color. The moisture content and crude ash increased with the increasing of wheat germ addition, while the crude oil and total solids decreased.

INTRODUCTION

Wheat germ is one of the major by – products of the wheat milling industry. The wheat germ is usually removed during commercial milling because its high fat content, which may cause rancidity of the flour. Germ also contains certain enzymes and colouring matters which injure the colour and baking value of the flour (Kent and Evers, 1994). However, it represents a unique source of highly concentrated nutrients and may therefore make a considerable contribution to cover human nutritional needs. Wheat germ protein is reported to have a high nutritive value comparable to that of animal proteins (Shurpaleker & Rao, 1977). It is an excellent source of tocopherols (Vitamin E) (Saito & Yamauchi, 1990 and Kevin, 1995) and have three times of protein, seven times of fat and 15 times of sugars and six times of mineral more than wheat flour. (Rao, *et al.,* 1980). Also, wheat germ exhibit interesting physico-chemical properties offering the possibility to use it as functional additives in food products such as bread (Vitti *et al.,* 1979; Wenlock *et al.,* 1983; El-Bardeny *et al.,* 1991; Cakmakli, *et al.,* 1995; Sidhu *et al.,* 1999 and Sidhu *et al.,* 2001);cookies(Bajaj *et al.*;1991); milk products (Godunova *et al.,*1986) ;meat products (El-Tanahy *et al* .,1990; Gnansambandam & Zayas., 1992 and Vani & Zayas, 1995)and macaroni (Pinarli *et al.*, 2004). Wheat germ can be used as a cocoa replacer in some confectionery products and in the production of antibiotics, pharmaceuticals and skin conditioners (Pomeranz, 1988; and Kent and Evers 1994). Mayonnaise is a semi-solid and oil in water emulsion. It prepares from egg yolk, salt, vinegar, oil, thickening agents and spices (as flavoring materials, especially mustard); it may also include suger or sweeteners, and other optional ingredients (Li-Hsieh & Regenstein, 1991 and Depree & Savage, 2001). Generally, many factors affect on the stability of mayonnaise such as the amount of oil and egg yolk, viscosity, method of mixing, relative volume of oil phase to aqueous phase and temperature (Harrison & Cunningham, 1985). In last years, many types of mayonnaise were introduced in the Egyption markets and most of these products were imported from USA and European countries. Only some types of mayonnaise were recently produced by some new private Egyptian food companies (Mostafa, 1999). Large amount of separated wheat germ from modern mills in Egypt is used for the animal feeding.The utilization of wheat germ in some common foods was the scope objective of this study. This study was carried out to investigate : 1- Study the possibility of utilizing wheat germ in some common cereal products such as cookies. 2- Prepare a cheaper, acceptable and high nutritive value beef burger using wheat germ. 3- Produce a new mayonnaise product from wheat germ and evaluation of its chemical and physico chemical properties.

MATERIALS AND METHODS

Materials

Wheat germ was collected from the cylinder mills of Middle & West Delta Company, Tanta Branch,Egypt. Wheat flour (72% extraction), Lean beef muscles, sunflower oil, natural vinegar (6%) and hen eggs were purchased from the local market of Alexandria, Egypt.

Methods

Proximate chemical composition:

Moisture , crude protein (total nitrogen X 6.25), crude fat, ash and crude fiber contents were determined followed AOAC (2000) methods.

Cookie preparation:

Wheat germ was dry heated to improve its shelf life by toasting it for 1 hr. at 100°C as recommended by Kent and Evers (1994).After that ,heated sample was mixed with other ingredients(300 gm sugar,300 gm palm oil,85gm water,15gm skim milk and 5gm salt / kg) for 1 min, then raising agent (sodium and ammonium bicarbonate) was added and continued mixing for another 24 min. the prepared dough was formed to soft cookies by using cookies machine. The cookies were baked at 205°C for 12 min in a revolving real oven mixer (National Manufacturing company, Lincoln, N3). The baked cookies were cooled to room temperature and packed in airtight containers.

Burger preparation:

Table (1) shows the formula of burgers that were carried out in the present study. TWG was ground in an electric mill "National mod. Mx-291 Ntypre", to pass through a 60 mesh sieve. Burger was formed in a disc form with 10 cm diameter, 0.5 cm thickness and 60 gm weight. Using a moulinex burger machine. Burgers were then packed in polyethylene bags and immediately kept in a deep freezer at -40° C for 10 days, then thawed in refrigerator at 5°C for 12 hrs before cooking. Burgers were wrapped loosely in foil and were cooked at 300°C on a grill for 20 min.

Table (1): Formula of beef burgers.

% wheat gem added	Meat	Wheat germ	Salt	Spice mixture*
Control	100	------	2	1
5%	95	5	2	1
10%	90	10	2	1
15%	85	15	2	1
20%	80	20	2	1

* 50% black pepper, 30% coriander, 5% cubeb, 5% cloves, 5% cinnamon and 5% red pepper.

Mayonnaise preparation:

Table (2) shows the formula of different mayonnaise samples which prepared by using TWG along with the control. TWG and mustard seeds were ground to pass through 60 mesh sieve using a moulinex mill. The egg yolk was separated and whipped beaten with vinegar and other ingredients except oil until creamed. The oil was first added to the creamed mixture at slow rate, drop by drop, then at a stable rate 0.5 ml/min., to obtain a stable emulsion. The mayonnaise products were packed in glass jars which were heat treated by immersing them in boiling water for 15 min and surfase dried in hot air oven at 105°C for 10 min . After that, products were stored at 4°C in refrigerator.

Table (2): Formula of laboratory mayonnaises.

Treatment	Oil (ml)	Wheat germ gm)	Vinegar(gm)	Egg yolk (gm)	Salt (gm)	Sugar (gm)	White pepper (gm)	Mustard (gm)	Total (gm)
Control	65	0	9.5	20	1.3	2.3	1.0	0.9	100
1	57.5	3	14	20	1.3	2.3	1.0	0.9	97
2	49.5	6	19	20	1.3	2.3	1.0	0.9	94
3	43.5	9	22	20	1.3	2.3	1.0	0.9	91
4	38.5	12	24	20	1.3	2.3	1.0	0.9	88

Burger characteristics:

Cooking loss and shrinkage:

Cooking loss was determined by weighing the burger immediately before and after cooking. Cooking loss was calculated from the following equation:

$$\% \text{ cooking loss} = \frac{W_1 - W_2}{W_1} \times 100$$

Where:

W_1 and W_2 = weight of the sample before and after cooking, respectively.

Burger area were measured immediately before and after cooking. Shrinkage was calculated as follows:

$$\% \text{ shrinkage} = \frac{A_1 - A_2}{A_1} \times 100$$

Where:

A_1 and A_2 = area of the sample before and after cooking, respectively.

Fat and moisture loss:

To calculate the amount of fat and moisture losses after cooking burger the following calculation was performed:

$$\% \text{ fat or moisture loss} = \frac{X_1 - X_2}{X_1} \times 100$$

Where:

X_1 and X_2 = gm fat (or water) in the burgers before and after cooking, respectively.

Evaluation of mayonnaise:

Color of mayonnaise was assessed using Lovibond Schofield tintometer as described by Mackinnery and Little (1962) while the viscosity of mayonnaise was estimated by using Brookfield viscometer Model HAT Brookfield Engineering laboratories, INC. Stoughton, MA, 02072, USA. as discribed by Acton and Saffle (1971). Emulsion stability was determined as mentioned by Hung and Zayas (1991). Thirty gram sample were incubated in a water bath for 30 min, at 20°C then centrifuged for 30 min at 3.000 rpm. The amount of separated oil was first measured and Emulsion capacity was calculated using the following equation:

$$\text{Emulsion capacity} = \frac{\text{gm oil in formulation} - \text{gm separated oil}}{\text{gm oil in formulation.}}$$

Total solids was calculated as 100 - % moisture content. Total soluble solids was estimated according to AOAC (2000) using an Abbe refractometer, Model 2WAJ, China.

Titratable acidity was determined according to Lee and Beuchat (1991) and calculated as acetic acid. pH of mayonnaise were estimate using Accumet pH meter, Model 90, wiss. Tech. Werkstattern D812 Weilheim.

Organoleptic evaluation:

Cookies, burger, and mayonnaise were organoleptically evaluated using nine points hedonic scale according to Gorczyca & Zabik (1979) and King *et al.*, (1990). The cooked burgers were judged for their surface color, texture, juiciness, flavor, and overall palatability, while cookies were judged for their appearance, flavor, tenderness and grain. Mayonnaise was organoleptically evaluated for their color, texture, flavor and overall acceptability.

Statistical analysis:

Data were subjected to analysis of variance and the means were further tested using Duncans Multiple Range test as outlined by Steel & Torrie (1980).

RESULTS AND DISCUSSION

Cookies:

The proximate chemical composition for cookies understudy, which prepared by using TWG at different levels are given in Table (3). Generally, the protein, crude fibers, fat and ash content increased markedly as the level of TWG substitution increased.

Sensory evaluation for cookies containing different ratios of TWG along with the control is presented in Table (4).Data showed no significant differences in flavor, tenderness and grain of control and cookies samples containing 5 and 10% TWG. Meanwhile there were no significant differences in cookies appearance and grain among control and 5%, 10%, 15% and 20% levels of TWG, but that of 25% (TWG) had less desirable appearance . The flavor and tenderness of control, 5% and 10% TWG were more acceptable and better than 15%, 20% and 25% levels of substitution.

The level of 10% TWG in cookies was found to be superior in sensory attributes than the other levels of supplementation (15%, 20% and 25%).

Table (3): Effect of TWG on the proximate composition of cookies.**

Constituent	Control*	5%	10%	15%	20%	25%
Protein	8.35 f	9.30 e	10.21 d	11.15 c	12.26 b	12.89 a
Crude fiber	0.43 d	0.51 cd	0.60 c	0.72 b	0.89 a	0.96 a
Fat	16.56 b	16.8 b	16.98 b	17.42 a	17.42 a	17.73 a
Ash	1.47 d	1.53 cd	1.65 c	1.90 b	1.90 b	2.03 a
Carbohydrates(by difference)	73.19	71.86	70.56	67.53	67.53	66.39
Total caloric values Kcal/100gm	475.2	475.84	475.9	475.49	475.94	476.69
Moisture content %	2.5	2.53	2.59	2.71	2.71	2.56

* 100% wheat flour (75% extraction).

** Means in a raw not sharing the same letter are significantly different at $P < 0.05$.

Table (4): Effect of TWG on the sensory attributes of cookies*.

Substitution level %	Appearance	Flavor	Tenderness	Grain
0(control)	7.5a	7.5 a	9.063 a	7.0 a
5	7.81 a	7.38 a	7.563 a	6.875 a
10	7.63 a	7.0 a	7.25 a	6.688 a
15	6.88 a	6.94 ab	6.625 ab	6.438 a
20	6.75 a	6.125 b	6.313 ab	6.188 a
25	5.56 b	5.88 b	6.25 ab	5.125 b

* Means in a raw not sharing the same letter are significantly different at $P < 0.05$.

Beef burger:

Data (Table 5) indicated that, as the proportion of TWG increased, the percentage of moisture, protein, fat and ash contents decreased while the percentage of crude fiber and carbohydrates increased . Mean of sensory panel scores for surface color, texture, juiciness, flavor and overall palatability of beef burger sample are presented in Table (6). Scores for panel surface color were not significantly different ($P<0.05$) among burger within the 5%, 10% and 15% replacement levels. Notwithstanding, the 20% level of TWG, resulted in burger had significantly lower surface color scores than their corresponding control. Texture, Juiciness and flavor values were more or less the same for burgers among all replacement levels. However, burger had 5% TWG was more acceptable (higher numerical scores) than control and other levels of replacement.

Burgers had TWG at the 5% and 10% replacement levels were accepted ($P<0.05$) in all palatability tests. On the other hand, the 20% level of TWG substitution , resulted in burgers had less desirable than their corresponding control. Data in Table (7) represent the effect of adding TWG on the moisture and fat contents of uncooked and cooked burgers. Moisture was found to be inversely related with TWG substitution level in both uncooked and cooked burgers. As the proportion of TWG increased, the percentage of moisture decreased. On the other hand, no significant differences were found in the fat content in both uncooked and cooked burgers due to the addition of TWG at all replacement levels comparing with control.

Table (5): Effect of TWG on the chemical composition of uncooked burger*.

Constituent	Control	5%	10%	15%	20%
Crude protein	51.68 a	47.91 ab	46.03 bc	43.83 cd	41.39 d
Crude fiber	1.1 e	1.72 d	2.51 c	2.94 b	3.73 a
Fat	36.80 a	33.84 b	32.03 bc	29.50 cd	27.03 d
Ash	8.76 a	8.47 b	8.38 b	8.25 b	8.21 b
Carbohydrates(by difference)	1.66	8.06	11.05	15.48	19.64
T. caloric values (Kcal/100g)	544.56	528.44	516.59	502.74	487.39
Moisture content%	64.51	61.53	59.57	56.95	53.71

*** Means in a raw not sharing the same letter are significantly different at P < 0.05**

Table (6): Effect of TWG on the sensory attributes of cooked burgers*.

Substitution level %	Surface color	Texture	Juiciness	Flavor	Overall palatability
0(control)	7.5a	7.6 a	7.5 a	7.5 a	7.5 ab
5	8.2 a	8.3 a	7.9 a	8.0 a	7.7 a
10	8.1 a	8.2 a	7.8 a	7.9 a	8.3 a
15	8.1 a	7.5 a	7.6 a	7.7 a	7.2 ab
20	5.5 b	7.6 a	7.5 a	7.4 a	6.1 b

Means in a column not followed by the same letter are significantly different (p<0.05).*

Table (7): Effect of TWG on the moisture and Fat content of uncooked and cooked burger.

Substitution level %	Uncooked burger		Cooked burger	
	Moisture %	Fat %	Moisture %	Fat %
0(control)	64.51	13.06	59.94	12.89
5	61.53	13.02	58.71	12.81
10	59.57	12.95	55.04	12.93
15	56.95	12.70	51.60	12.75
20	53.71	12.51	48.19	12.69

*** Means in a raw not sharing the same letter are significantly different at P < 0.05**

Data for cooking characteristics of cooked burgers containing different levels of TWG are shown in Table (8). The cooking loss percentage increased markedly with increasing the replacement level of TWG. The cooking loss for control sample was more or less the same with 5% TWG replacement burger. The moisture loss increased significantly with increasing replacement percentage of TWG.

The substitution by 5%, 10% or 15% TWG generally improved the shrinkage defect since it decreased the percentage of shrinkage significantly compared with other samples. Notwithstanding, the replacement by 20% TWG increased the percentage of shrinkage significantly. TWG 10% as meat substitute can be recommended in this respect.

pH values of cooked burgers are presented in Table (8). Increasing of TWG substitution level increased the pH-value of cooked burgers markedly. The pH value ranged between 6.06 and 6.52 in cooked burgers.

Table (8): Effect of TWG on the characteristics of cooked burger*.

Substitution level %	Cooking loss(%)	Moisture loss(%)	Fat loss(%)	Shrinkage (%)	PH value
(control)	17.22c	23.1 d	18.30ab	26.04 b	6.06
5	17.13 c	20.93 e	18.43 a	22.56 cd	6.13
10	17.85bc	24.09 c	17.99 b	21.68 d	6.24
15	18.48b	26.15 b	18.19ab	23.09 c	6.41
20	19.55 a	27.83 a	18.38 a	28.09 a	6.52

* Means in column not followed by the same letter are significantly different ($p<0.05$).

Mayonnaise:

The moisture content of mayonnaise increased with increasing of TWG content in mayonnaise formula, while the fat content drastically decreased due to small amounts of oil needed for manufacturing of mayonnaise containing TWG. Slight increase in ash content of mayonnaise was observed in increment the percentage of TWG. The values of ash content ranged from 1.8% (control) to 2.76% (formula no. 5). Percentage of total solids of different formula decreased with increasing of TWG addition, while the total soluble solids increased (Table 9).

Table (9): Chemical analysis of mayonnaise prepared by TWG*.

Formula*	Moisture (%)	Total solids	Total soluble solids	Fat	Ash
1	20.59 e	79.41 a	3.5 e	73.9 a	1.84 e
2	28.03 d	71.97 b	5.6 d	62.64 b	2.06 d
3	33.86 c	66.14 c	7.8 c	51.21 c	2.42 c
4	37.21 b	62.79 d	10.1 b	45.80 d	2.54 b
5	40.32 a	59.68 e	12.4 a	39.40 e	2.76 a

* Means in a column not followed by the same letter are significantly different ($P < 0.05$).

The mean score for the panel evaluation of mayonnaise color, texture, flavor and overall palatability are summarized in Table (10). The data indicated that there was no significant difference in color, texture, flavor and overall palatability of the control and mayonnaise containing 3% TWG .Moreover, there was no significant difference in mayonnaise flavor among control and 3%, 6%,and 9% levels of whole wheat germ. Notwithstanding, mayonnaise had 6%, 9% and 12% TWG levels were the least desirable in texture and overall palatability. On the basis of sensory evaluation, it could be concluded that the best level of TWG addition was up to 6%.

Table (10): Effect of TWG on the sensory attributes of mayonnaise*.

Treatment	Color	Texture	Flavor	Overall palatability
Control	8.6a	8.1 a	8.0 a	7.8 a
3	8.4 a	8.1 a	7.9 a	7.6 a
6	7.8 a	7.5 ab	7.6 a	7.3 ab
9	6.7 b	7.2 ab	7.3 a	7.2 ab
12	6.4 b	6.7 b	7.1 b	6.6 b

* **Means in a column not followed by the same letter are significantly different ($P < 0.05$).**

Table 11 showed that the addition of TWG decreased significantly the emulsion stability compared to the control. The viscosity of control was significantly higher than that of samples containing 3, 6, 9 or 12% TWG. There is an inverse relationship between particle size and viscosity of mayonnaise (Jacobsen *et al.,* 2000, 2001). The pH values and acidity decreased with increasing the levels of whole wheat germ. The pH values varied between 4.02 (in mayonnaise containing 3% TWG) and 4.29 (in control sample).Acidity (as acetic acid) of mayonnaise sample varied between 2.44 and 3.11% . The data agree with that published by Mostafa, (1999) who found that the pH values of mayonnaise samples, which collected from local Egyptian markets, ranged between 3.8 to 4.21 and acidity (as acetic acid) ranged from 2.38 to 6.71%.

Table (11): Effect of TWG on emulsion stability, viscosity, acidity and pH-value of mayonnaise Samples* .

Added TWG (%)	Emulsion stability	Viscosity (Poise)	Acidity (as g acetic acid/100 g sample)	PH- Value
Control	100a	85 a	2.44 d	4.29
3	96 b	77 b	2.74 c	4.21
6	95 bc	72 c	2.85 c	4.14
9	95 bc	68 d	2.98 b	4.07
12	93 c	63 e	3.11 a	4.02

* **Mean in a column not followed by the same letter are significantly different ($P<0.05$).**

Data given in Table (12) show the values of the three primary colors of the mayonnaise samples. The red value of 6% TWG addition was 3 folds of control, while the yellow value was more or less the same for control and 3% or 6% TWG addition. The blue value (0.2) was observed for control and 3% level of TWG while, 6%, 9% and 12% TWG addition increased the blue value to 0.3.However, the dominant wave length ranged between 572 and 575 nm. The highest value was recorded for 6% TWG addition compared to 573 nm for the control. Visual density values ranged between 0.19 and 0.24. The control had the lowest value of visual density, while the 6% formula scored the highest value. The brightness percentage ranged between 56.8 and 63.8%, while the percentage of color saturation ranged between 85.106 and 90.476. There was an inverse relationship between the visual density and both of brightness and color saturation. Aluko and McIntosh, (2005) found that increasing level of canola protein in mayonnaise reduced the whiteness and increased the reddish-brown color of mayonnaise.

Table (12): Color of mayonnaise containing different amount of TWG (Lovibond and C. I. E. systems).

whole wheat germ added (%)	Red	Yellow	Blue	C. I. E. Chromaticity Co-ordinates			Hue dominant wave length nm	Saturation of color (%)	Visual density	Brightness (%)
				X	Y	Z				
Control	0.5	20.8	0.2	0.431	0.504	0.065	573	90.467	0.19	63.8
3	1.3	20.8	0.2	0.445	0.495	0.06	572	88.88	0.23	58.2
6	1.4	20.8	0.3	0.444	0.491	0.065	575	85.106	0.24	56.6
9	1.0	20.6	0.3	0.434	0.536	0.03	573	88.636	0.21	60.9
12	1.0	20.6	0.3	0.434	0.536	0.03	573	88.636	0.21	60.9

In conclusion, TWG can be usefully and successfully applied in cookie, burger and mayonnaise manufacture by substitution levels up to 10,10 and 6% ,respectively.

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الاستفادة من جنين القمح في بعض المنتجات الغذائية

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في هذه الدراسة تم استخدام جنين القمح المحمص في تصنيع ثلاثة منتجات هي البسكويت والبيف برجر والمايونيز . وقد وجد أن استبدال جنين القمح المحمص إلي مستوي ١٠% من دقيق القمح قد أنتج بسكويتاً له نفس الخواص الحسية للعينة المصنعة من ١٠٠% دقيق بينما رفع النسبة إلي ١٥% أنتج بسكويتاً مرفوضاً حسياً . وأوضح التحليل الكيماوي للبسكويت الناتج أن رفع نسبة الاستبدال من جنين القمح قد رفعت محتوي البسكويت الناتج من البروتين والزيت والرماد والألياف بينما لم تختلف القيمة الكلية للسعرات بين العينات تقريباً. كما أوضحت نتائج التقييم الحسي للبيف برجر المصنع باستخدام جنين القمح المحمص أن إضافة ١٠% من جنين القمــح إلــي مكونــات البرجر قد أعطي ناتجاً لا يختلف في صفاته الحسية عن ذلك المصنع بدون إضافة جنين القمح في حين انخفضت درجة الاستساغة في البرجر المصنع باستخدام ١٥% من جين القمح رغــم عــدم اختلاف باقي الصفات معنوياً مثل اللون، القوام، النكهة والعصيرية.وقد اتضح أن إضــافة ١٠% من جنين القمح في صناعة البرجر قلل من فاقد الدهون ونسبة الانكماش معنوياً مقارنة بكل مــن الكنترول والعينة المضاف إليها ٥% جنين القمح المحمص. لم تختلــف نتــائج التقيــيم الحســي للمايونيز المحتوي علي ٣% جنين قمح محمص معنوياً عن مثيلتها للكنترول. بينما اختلف تقبــل المايونيز الناتج برفع نسبة الإضافة إلي ٦% رغم عدم اختلافه عن الكنترول في اللون والنكهــة ولكن في القوام. وأدت زيادة نسبة إضافة جنين القمح إلي تقليل كمية الزيت وزيادة كميــة الخــل المطلوبين للوصول إلي أفضل قوام للمايونيز وعليه فقد ارتفع النسبة المئوية للحموضة في العينات بارتفاع نسبة جنين القمح المحمص بينما لم تختلف قيمة ثبات المستحلب معنوياً في حالة المايونيز المصنع باستخدام ٣% جنين القمح عنها في حالة (الكنترول). كما اختلف لون المايونيز المقاس باللوفيبوند الناتج نظراً لاختلاف محتواه من جنين القمح المضاف والزيت والخل . وقــد تــراوح اللون من الأصفر الشاحب إلي الأصفر الغامق في العينات.

وعموماً فإن إضافة جنين القمح قد ضاعفت من قيمة اللون الأحمر (مرتين أو ثلاث) فــي حين كانت أقل تأثيراً علي كل من القيم الخاصة باللون الأصفر أو الأزرق، وعموماً لم يكن لزيادة الإضافة من جنين القمح تأثير معنوي للرفض الحسي إلا عند مستوي ٩% من جنين القمــح.أدت زيادة مستوي الإضافة من جنين القمح إلي انخفاض نسبة الزيت وارتفاع نسبة الرطوبة وارتفــاع نسبة الرماد في المايونيز الناتج ووجدت علاقة عكسية بين نسبة المواد الصلبة الكلية ونسبة المواد الصلبة الذائبة.