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FUNCTIONAL PROPERTIES OF DEFATTED WHEAT GERM PROTEIN ISOLATE

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ABSTRACT

The research examined the functional properties of defatted wheat germ protein isolate (DWGPI) and compared it with commercial casein. The results of the chemical composition of samples raw wheat germ RWG, defatted wheat germ DWG and DWGPI showed that DWGPI was higher than RWG and DWG in protein content (86.18) %, and DWG was higher in carbohydrate content (58) %, while the highest percentage of fat and moisture reached (11.8, 9.5) % in the RWG sample. respectively. In addition, the functional properties of wheat germ protein isolate (DWGPI) were compared with commercial casein protein. The solubility at different levels of pH for both samples showed that the highest percentage of solubility at pH 12 was (70.5, 65.6) %, respectively, and the lowest percentage of solubility at pH 4 was (13.3, 12.8) %, respectively. While the highest ability to emulsify was (86, 83) % at pH 12 and (75, 65.6) % for emulsion stability for both protein isolate and casein samples, respectively. While the highest value of foaming ability was at pH 12, about 82% and 74%, and the lowest value was at pH 4, about 12% and 8% for protein isolate and casein, respectively. As for foam stability at different pH levels and times, the highest value at pH 12 was (90, 84, 73, 72) % for protein isolate and (87, 75, 64, 60) % for casein, and the lowest value was at pH 4. The highest value for water absorption at pH 10 was (6.36, 11.1) ml water/gm protein, and the lowest value at pH 4 was (1.49, 2.05) ml water/gm protein for protein isolate and casein, respectively. While the fat holding capacity of the protein isolate was (1.74) ml oil/gm protein and for casein (1.32) ml oil/gm protein.

Keywords: Chemical composition, protein ISOLATE, functional properties, casein, foam stability.

[*] **This article is taken from the first researcher's master's thesis.**

الخصائص الوظيفية للمعزول البروتيني منزوع الدهن لجنين القمح

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الخلاصة

تناول البحث دراسة الخصائص الوظيفية للمعزول البروتيني لجنين القمح منزوع الدهن (DWGPI) ومقارنتها مع الكازين التجاري. أذ بينت نتائج التحليل الكيميائي للعينات جنين القمح الخام RWG وجنين القمح منزوع الدهن DWG و DWGPI . أن DWGPI كان أعلى من RWG وDWG في محتوى البروتين (86.18)%، وكان DWG أعلى في محتوى الكربوهيدرات (58)%، بينما أعلى نسبة للدهون والرطوبة بلغت (11.8، 9.5)% في عينة RWG على التوالي، بالإضافة إلى ذلك، تمت مقارنة الخصائص الوظيفية للمعزول البروتيني لجنين القمح (DWGPI) مع بروتين الكازين التجاري. حيث أظهرت قابلية الذوبان عند مستويات مختلفة من الأس الهيدروجيني لكلا العينتين أن أعلى نسبة ذوبان عند الأس الهيدروجيني 12 كانت (70.5، 65.6) %، على التوالي، وأقل نسبة للذوبان عند الرقم الهيدروجيني 4 كانت (13.3 , 12.8)% على التوالي. بينما كانت أعلى قابلية على الاستحلاب هي (86 , 83)% عند الرقم الهيدروجيني 12 و (75 , 68.3) % لثبات المستحلب لكل من عينات المعزول البروتيني والكازين على التوالي. في حين كانت أعلى قيمة لقابلية تكوين الرغوة عند الرقم الهيدروجيني 12 حوالي 82 % و 74 % وأقل قيمة كانت عند الرقم الهيدروجيني 4 حوالي 12% و8% للمعزول البروتيني والكازين على التوالي. أما بالنسبة لثبات الرغوة عند مستويات وأزمنة مختلفة من الأس الهيدروجيني فإن أعلى قيمة عند الأس الهيدروجيني 12 كانت (90 ,84 ,73 , 72)% للمعزول البروتيني و (87 ,75 ,64 ,60) % للكازين واقل قيمة كانت عند الاس الهيدروجيني 4. وكانت أعلى قيمة لقابلية امتصاص الماء عند الأس الهيدروجيني 10 هي (6.36 , 11.1) مل ماء/جم بروتين، وأقل قيمة عند الأس الهيدروجيني 4 كانت (, 1.49 2.05) مل ماء/جم بروتين. للمعزول البروتيني والكازين، على التوالي. بينما بلغت قابلية امتصاص الدهون للمعزول البروتيني (1.74) مل زيت / جم بروتين وللكازين (1.32) مل زيت / جم بروتين.

الكلمات المفتاحية: التركيب الكيميائي، المعزول البروتيني، الخصائص الوظيفية، الكازين، ثباتية الرغوة .

INTRODUCTION

The wheat germ is one of by-product of milling, it constitutes about 2-3% of the total weight **(Zhang *et al*.,2023: Ling *et al*.,2019)**. It is a rich source of proteins, minerals and vitamins **(Nashmi&Naser, 2022: Wang *et al*.,2017)**. Many studies reported that wheat germ was the best product in milling process due to it contains high nutritional value, such as high content in essential amino acids including threonine, lysine and methionine which they were the highest among the rest grain, and most of the nutrients elements were found in the wheat germ, especially (protein, fat, minerals and sugar) compared to the endosperm **(AL-Sadoon & Naji, 2019; Zangana & AL-Shamery, 2016).**

(Gao *et al*., 2023; Mohammed *et al*., 2019) indicated that the percentage of protein in wheat germ was 25% -30%, with its high content of essential amino acids, especially lysine, arginine, and threonine. The ash was 3% - 5%, it was rich in minerals such as zinc, potassium, phosphorus and magnesium, as well as the fiber content was 1.5% - 4.5%, while the fat content was (8 – 14) %, respectively. The unsaturated fatty acids such as oleic, linoleic, and linolenic acids were found in wheat germ in high proportion. While, the percentage of carbohydrates was (44 – 54) %. The wheat germ also contains some vital compounds that play an important role as antioxidants such as flavonoids, steroids, glutathione, alpha tocopherol, and octacosatols, furthermore it is a highly appealing and promising plant protein source, which contains albumin 34.5 %, globulin 15.6%, glutelin 10.6%, and prolamine 4.6% **(Liu *et al*., 2024).**

The functional properties of protein can be divided according to the mechanism of protein action into three groups. The first was related to the water properties such as solubility, ability to bind water and fat thickness **(Mahdi., 2016; Foegeding & Davis, 2011)**. The second was related to the protein structure and rheological properties such as adhesion, elasticity, viscosity and gelation. The third was related to the protein surface such as the ability to form foam, the ability to emulsify, the ability to whip, the formation of films between the protein and the oil. In addition, the sensory characteristics of protein such as color, texture, flavor and etc**, (Malecki *et al*., 2021; Nahla& Makarim, 2018; Moure *et al*., 2006)**. The proteins demand was increased with raised in prices of animal proteins had to necessary for getting the alternatives of protein which have good functional qualities for use in various fields of food manufacturing **(Atta&EL-Shenawi, 2013)**. The aim of this research is to study the functional properties of wheat germ protein isolate and compare them with the functional properties of commercial casein.

MATERIALS AND METHODS:

Wheat germ was obtained from mill in the Baghdad city, which is affiliated with the Iraqi Ministry of Trade. It is the result of the milling process of a mixture of several cultivars of wheat grains. Casein was purchased from the local market with a protein content of 82%.

Preparation of the raw wheat germ sample:

The enzymes of raw wheat germ were inactivated by heating for 20 min at 105^{o}C **(Zhu *et al*., 2006; Claver & Zhou, 2005)**, defatted with n-hexane for 8 h using a Soxhlet device and it was dried using an evaporator at (40 ^{o}C), then the defatted wheat germ was grinded using an electric grinder and sieved through a 60-mesh screen . The samples were kept in sealed glass jars at 4 ^{o}C until used.

Preparation of WGPI from defatted wheat germ:

The WGPI was prepared according to **Zhu *et al*., (2006)**, with some modifications. Defatted wheat germ flour was mixed with a solvent (NaCl 1M) with ratio of 1:10 (sample: solvent). Firstly, the pH was adjusted to 9.5 using Na OH (1 M), mixing for 30 minutes, then centrifuged (8000 rpm for 20 minutes) at room temperature.

After that, the filtrate was separated from the precipitate, the filtrate was taken, and the acidity of the it was adjusted to 4 using of HCL (1 M). The protein precipitate was separated using centrifugation (8000 rpm) for 20 minutes, the acidity of the precipitate was adjusted to pH 7 using NaOH (0.1 M). Finally, they were lyophilized and kept by freeze in sealed plastic containers until use.

Chemical Analysis:

The chemical composition of raw wheat germ (RWG), defatted wheat germ (DWG), and defatted wheat germ protein isolate (DWGPI) was estimated as stated in **AACC, (2000)**, and the percentage of carbohydrates was estimated by the difference from other components as in **Pearson, (1970)**.

Estimation of functional properties:

Solubility capacity:

The Solubility for samples (DWGPI, casein) were estimated as in **Catterjee *et al.*, (2015)**, where 50 mg of sample was weighed and added to 20 ml distilled water over different pH ranges (1 - 12) using a solution of HCL and NaOH, 1 molar concentration. Then it was left for 15 minutes, after which centrifugation was performed at a speed of 10,000 rpm for 15 min. The filtrate was taken and the percentage of protein was estimated using the Micro Kjeldahl method, then the % solubility was calculated as follows:

% solubility = protein content in the filtrate / percentage of protein in DWGPI x 100

Water Holding Capacity (WHC):

The method mentioned in **Jasim & Nasser., (2023)** was followed to measure the WHC. 1 gm of sample (DWGPI, casein) was mixed and added to 20 ml of distilled water. It was mixed using a mixer (Vortex) for 5 minutes and the pH was adjusted. To (4, 7, 10, 12) and left for 15 minutes at room temperature, then centrifugation was performed at a speed of 10,000 rpm for 10 minutes, after that the WHC was calculated according to the following equation:

$$WHO = \frac{W_2 - W_1}{W_0}$$

where:

$W_{1=}$ the weight of the tube plus the dry sample. $W_{2=}$ the weight of the tube plus the sediment. $W_{0=}$ the weight of the dry sample.

Oil Holding Capacity (OHC):

Oil holding capacity was measured as stated in **Onsaard *et al.*, (2010)**, by mixing 1 g of sample (DWGPI, casein) with 10 ml of oil in a centrifuge tube using a mixer (Vortex) for 5 minutes and leaving it for 15 minutes at room temperature. Then, centrifugation took place for 10 minutes at 10,000 rpm, the floating part was removed, then the tube was weighed, and the percentage of OHC was calculated from the following equation:

$$OHC\ (gm\ Oil/\ gm\ Sample) = \frac{F_2 - F_1}{F_0}$$

Where:

$F_{1=}$ the weight of the tube plus the dry sample. $F_{2=}$ the weight of the tube plus the sediment. $F_{0=}$ the weight of the dry sample.

Capacity & Stability of foam:

The foam capacity (FC) and foam stability (FS) of samples (DWGPI, casein) were measured by the method described **Ayed & Naji., (2017)**, by mixing 1 g of the sample with 100 ml of distilled water and a pH of (4, 7, 10, 12) using a 1M NaOH or HCL solution, and mixing the mixture. With an electric mixer at maximum speed for 5 minutes, then the mixture was transferred to a 100ml graduated cylinder, and the volume was measured before and after mixing with the electric mixer, and the following equation was applied:

%FC= Volume after mixing - Volume before mixing / Volume before mixing) x 100

As for the stability of the foam (FS), it was measured by measuring the volume of the foam within (0, 15, 30, 45, 60) minutes, and the following equation was used:

%FS= Foam volume after time / initial foam volume x 100

Emulsifying activity and emulsifying stability:

The emulsifying activity (EA) and emulsifying stability (ES)were estimated as stated **Sharma *et al.*, (2016)**, with some modifications, by mixing 5 ml of sunflower oil with 5 ml of sample (DWGPI, casein) with a concentration of (0.25%) and a pH of (4, 7, 10, 12). Then the mixture was stirred at a speed of 10,000 rpm using a homogenizer for a minute, after which centrifugation was performed for 5 minutes and at a speed of 3,500 rpm. The graduated cylinder was used to measure the volume of the emulsified layer, and the following equation was applied:

%EA= Emulsion layer volume/ total volume × 100

The stability of the emulsion was measured by placing it in a water bath at a temperature of 85°C for ½ hour, then centrifuging it at 3500 rpm for 5 minutes. The graduated cylinder was used to measure the size of the emulsion layer as follows:

%ES= Emulsion layer volume after heating/total volume before heating × 100

Statistical analysis:

The statistical program Statistical Analysis System – **SAS., (2018)** was used to analyze the data to study the effect of different parameters on the studied traits according to a completely randomized design (CRD), and the significant differences between the means were compared with the Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

chemical composition :

Table 1 shows the chemical composition of RWG, DWG, and DWGPI, where the percentage of moisture, ash, fat, protein, and carbohydrates in RWG was (9.5, 4.1, 11.8, 27.0 and 47.6) % and in DWG was (6.46, 4.7, 0.84, 30.0 and 58.0) %, while in DWGPI it was (4.0, 2.3, 0.2, 86.18 and 7.32) %, respectively. The percentage of protein in DWGPI was 86.18%, and this percentage is higher than Hassan et al., (2010), they were found that protein isolate of wheat germ was 75.38%, while AL- Sadoon & Naji, (2019) also reported that the percentage of protein in the protein isolate of wheat germ and the protein isolate of grain fraction was 73% and 74%, respectively. While, Rahman, (2018) noted that the percentage of protein in the protein isolate prepared from mung seeds was 83.70%. While Abarghoei et al., (2023) stated that the protein content in wheat germ protein isolate reached at 80.31%. The RWG was the highest in moisture and fat content (9.5 and 11.8) % as well as the DWG was the highest in carbohydrate content about 58%. The lowest percentage of moisture, ash, fat, and carbohydrates was in DWGPI sample, which amounted to (4.0, 2.3, 0.2, and 7.32) %, respectively. Those results were identical to Zhu et al., (2006), they mentioned that percentage of ash in wheat germ protein isolate was 2.32%. As for carbohydrates, the results were close to Zhu et al., (2006) which they found the carbohydrates were 7.71% .

Table (1): Chemical composition of RWG, DWG, DWGPI sample

Sample	%Moisture	%Ash	%Fat	%Protein	%Carbohydrate
RWG	9.5	4.1	11.8	27	47.6
DWG	6.46	4.7	0.84	30	58
DWGPI	4.0	2.3	0.2	86.18	7.32

*(RWG)= Raw wheat germ, (DWG)= defatted wheat germ flour, (DWGPI)= defatted wheat germ protein isolate

Estimation of functional properties:

Solubility

Table 2 shows the solubility of DWGPI, where the highest solubility was 70.2% at pH 12, while at same pH, the highest solubility of casein was 65.6%. The lowest solubility was at the pH 4 for both DWGPI and casein (13.3 and 12.8) %, respectively. Rahman, (2018) indicated that the solubility of mung protein isolate was (60.23%) at pH 8 and decreased to 27% at pH 5, Zhu et al., (2010) reported that the highest solubility of defatted wheat germ protein isolate reached 83.6% at pH 12, and the lowest solubility was 3.8% at pH 4. The decrease in solubility at pH (4 and 5), due to being close to the electrical neutralization point at which the amino acids are transformed into the non-ionized form. The resultant decrease in the charge of the protein and solubility, whereas the solubility increased when the pH would be towards the basic and acidic numbers which far from the electrical neutralization point, due to the increase in the resultant charge of the protein and the transformation of the amino acids into the electrically neutral state. Ionized, thus increasing solubility (Hmod & Naji, 2019). The results of the statistical analysis indicated significant differences ($p<0.05$) in the solubility of protein isolate and casein separately at the pH 1 to 12. Thus, there were significant differences when compared the protein isolate and casein at the pH 2, 11 and 12 .

Table (2): Solubility of protein isolate and casein at different pH.

% Solubility		PH	LSD value
DWGPI	**Casein**		
23.0	21.3	1	2.95 NS
52.2	42.1	2	4.89 *
31.4	29.3	3	3.02 NS
13.3	12.8	4	2.19 NS
15.4	14.5	5	2.06 NS
18.3	16.2	6	2.68 NS
19.4	20.4	7	1.96 NS
23.5	22.3	8	2.08 NS
45.2	42.2	9	3.47 NS

56.6	54.4	10	3.62 NS
64.3	58.2	11	4.97 *
70.2	65.6	12	4.28 *
6.408 *	**5.946 ***	**LSD value**	**---**

*P≤ 0.05, NS=non-significant

Absorption of water and fat

Water and oil holding capacity (WHC and OHC)

The water and fat holding capacity of the protein isolate and casein at different pH was 4, 7 and 10 as shown in Table 3. The water holding capacity of the protein isolate at different pH levels was (1.49, 2.95 and 6.36) ml/g and for casein was (2.05, 4.15 and 11.1) ml /g respectively. The proteins of casein were noted that were the best in their ability for holding water, and the isolates of protein with the differences in PH. Those results were agreed with **Ivanova *et al.*, (2014)**, they were indicated that the water holding capacity of the sunflower protein isolate was 8.57 ml/g. While, **Toliba, (2004)** stated that the water holding capacity of the flaxseed protein isolate was 6.8 ml/g. On the other hand, when studying the protein isolate of tuna by **Yoon *et al.*, (2018)**, the ability for holding water and pH were increased, because of opening the protein chains and exposing the polar amino acids to the medium, that led the increasing of concentrations of non-polar acids into protein structure, thus increasing the ability of the isolate protein to retain water.

Table (3): Water holding capacity of protein isolate and casein in different pH

Water abs. (ml/g)		**PH**	**LSD value**
Casein	**Protein isolate**		
2.05	1.49	4	1.02 NS
4.15	2.95	7	1.88 NS
11.1	6.36	10	2.59 *
2.062 *	**1.877 ***	**LSD value**	**---**

*P≤ 0.05, NS= non- significant; Water abs= Absorption of water

The fat-holding ability of DWGPI and casein were (1.74 and 1.32) ml oil/gm protein. These results were corresponding with other study in its ability of fat-holding. The ability of fat-holding for wheat germ protein isolate was less than of soy protein isolate as 1.042 g/g and 2.434 g/g, respectively (**Zhu *et al.*, 2010**). In addition, Jasim & Nasser, (2020) stated that the fat-holding ability of whey protein was 1.24 ml of oil/ gm protein. Whereas, **Hassan *et al.*, (2010)** noted that the fat-holding capacity of the wheat germ protein isolate was 1.28 gm oil/gm protein and less than the capacity of fat-holding for wheat protein isolate under study. The fat-holding capacity depends on the non-polar groups in the side chains of the protein, and the

ability to hold the fat depends on several factors, including the solubility and degree of denaturation of the protein (**Luma *et al.*, 2020; Hmod & Naji, 2019**).

Foaming capacity

Table 4 shows the foaming ability of DWGPI and casein at different pH were 4, 7, 10 and 12. The ability to form foam for DWGPI was (12, 16, 44 and 82) % and for casein (8, 12, 34 and 74) %. The results showed, the lowest in ability of DWGPI and casein to form foam was at pH 4. The ability to foam form DWGPI was increased with decreasing acidity, becoming its largest value at pH 12, as it became (74 and 82) % for the protein isolate and casein. Those results were consistent with Toliba, (2004), the ability to foam increased significantly with the increasing in pH, and this was attributed to increase the resulting charge of the protein, which limits hydrophobic interactions and increasing the solubility and flexibility of the protein, that leads to increased diffusion of the protein at the interface (water and air), and thus increasing the ability to form foam (**Meriles *et al.*, 2019; Malik& Saini, 2017; Yuliana *et al.*,2014**) .

Table (4): Foaming ability of protein isolate and casein at different pH.

% Foaming ability		PH	LSD value
Casein	Protein isolate		
8	12	4	3.91 *
12	16	7	3.79 *
34	44	10	5.63 *
74	82	12	5.76 *
6.92*	7.84*	LSD value	---

*P≤0.05

Table 5 indicates the stability of the foam formed from DWGPI and casein proteins as comparison proteins at different pH levels (4, 7, 10, 12) and different times (15, 30, 45, 60) minutes. It is noted from the table that the stability of the foam increases with the decrease in the acidity of the mixture, and this is consistent with what was reached by **Ma *et al.*, (2018); Li *et al.*, (2018)** when using protein isolates from cottonseeds and soybeans, and they attributed this to the increase in protein solubility with increasing pH, which increases the diffusion of protein at the interface between water and air, thus reducing surface tension and increasing foam stability. **Mau & Hua, (2012)** indicated a decrease in the stability of the foam at the electrical neutralization point, as the stability of the foam depends on the thickness, cohesion, and viscosity of the protein membrane surrounding the air bubbles. Therefore, the reason for the decrease in foam stability may be due to the repulsion of charges between the protein molecules, leading to a decrease in the cohesion of the membranes. Protein and the breakdown of foam quickly. Increasing the pH above 4 increases the total charge of the protein and thus increases the solubility and elasticity of the protein, which leads to the protein spreading on the surface separating water and air quickly, enveloping the air molecules and forming foam **(Tariq *et al.*, 2023; Hmod & Naji, 2019).**

Table (5): Foam stability of protein isolate and casein for different pH

		15	30	45	**60**
Protein isolate	4	0	0	0	**0**
	7	57	48	40	**32**
	10	61	54	51	**50**
	12	90	84	73	**72**
casein	4	0	0	0	**0**
	7	56	51	42	**33**
	10	60	55	50	**48**
	12	87	75	64	**60**
LSD value		7.95 *	6.27 *	6.84 *	**6.02 ***

Emulsifying activity and stability

Table 6 indicates the ability of DWGPI and casein proteins to form an emulsion at different pH levels (4, 7, 10, 12). The table shows that the highest percentage of emulsification ability was at pH 12 as it reached (86, 83) % for both DWGPI and casein. respectively, while the lowest percentage of emulsification was at pH 4, where it reached (27,37) % for DWGPI and casein, respectively. The increase in the ability of proteins to form emulsions with increasing pH is due to the increase in protein solubility and the increase in the balance of the (hydrophilic/ hydrophobic) groups of the protein on the water surface, which increases the diffusion of the protein at the interface (water/oil) and reduces the surface tension force in the phase separator **(Malik & Saini, 2017; Sharma *et al*., 2016).**

Soluble proteins form a layer surrounding the oil droplets, where the hydrophobic groups in the protein are linked to the lipid interface, while the polar and hydrophilic groups are linked to the surface of the liquid medium **(AL-Wahed Salbukh *et al*., 2019; Khairy *et al*., 2018)**. Many factors affect the ability to form an emulsion, including solubility, pH, the resultant charge of the protein, and the balance of hydrophilicity and hydrophobicity in the protein **(Hammood & Nasir, 2017; EL-Nasri & EL-Tinay, 2007)**. The results of the statistical analysis showed that there were significant differences in the emulsification values at pH (4, 7, 10) for both DWGPI and casein, at a significant level ($p < 0.05$).

Table (6): Emulsifying ability of protein isolate and casein for different pH.

% EA OF casein	**% EA OF protein isolate**	**PH**	**LSD value**
37	27	4	4.92 *
41	54	7	5.07 *
64	72	10	4.83 *
83	86	12	3.27 NS
6.29 *	7.85 *	LSD value	---

* P≤ 0.05, NS= non- significant, EA= Emulsifying ability

Table 7 indicates the stability of the emulsion formed in the presence of DWGPI and the casein comparison proteins. It is noted from the table that the stability increased with increasing pH or decreasing acidity, as the highest value of stability was reached at pH 12,

where it was (68.3, 75) % DWGPI and casein, respectively, and the lowest value was at pH 4 (10.2, 12.3) % DWGPI and casein, respectively. The results were consistent with the findings of **Chao *et al.*, (2018); Garcia- Vaquero *et al.*, (2017**). They showed that the stability of the emulsion increases with increasing pH due to the increased solubility of the protein at high pH, which works to increase the amount of absorbed protein in the interface (water/oil) and the formation of a strong, cohesive membrane maintains the emulsion for long periods. Also, increasing the pH increases the charge on the protein surface, causing repulsion of the fatty granules coated with protein membranes and preventing them from sticking together and being separated in the aqueous phase. The results showed Statistical analysis revealed significant differences at the level of significance ($p < 0.05$).

Table (7): Emulsion stability of protein isolate and casein at different pH

ES of casein %	ES of protein isolate %	PH	LSD value
10.2	12.3	4	2.88 NS
23.4	43.2	7	5.02 *
54.6	61.4	10	5.66 *
68.3	75	12	6.41 *
7.55 *	8.41 *		---

*=P≤0.05, NS= non- significant; ES=Emulsion stability,

CONCLUSION

Wheat germ is a rich source of proteins, and wheat germ protein isolate has good functional properties that make it an important material in food manufacturing and the preparation of some foods with special specifications. The protein isolate was superior to casein in terms of solubility, emulsion formation and stability, stability, foam formation, and ability to absorb fat, while casein was superior in ability to hold water.

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