

CONTRIBUTION TO THE ENRICHMENT BREAD WITH THE WHEAT GERM

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Résumé

Le travail présenté porte sur l'étude de l'enrichissement du pain avec le germe de blé. Nous avons enrichi le pain avec le germe de blé une fois à l'état non broyé et une autre à l'état broyé aux proportions suivantes : 2.5 – 5 – 7.5 – 10 – 12.5 et 15 %. Nous avons caractérisé nos échantillons et cela en effectuant des analyses chimiques, aussi nous avons déterminé la teneur en gluten également ses propriétés rhéologiques notamment le ramollissement et l'extensibilité et la réalisation d'un essai de panification. A la fin nous avons procédé à la discussion des résultats obtenus dont les plus importants: L'incorporation du germe est acceptable à des proportions allant jusqu'à 5%. L'utilisation du germe à l'état broyé est conseillée afin d'éviter la présence des tâches sur la croûte du pain ce qui peut gêner le consommateur.

Mots clés: Blé, Farine, Germe, Gluten, Pain

Abstract

The work presented concerns the study of the enrichment of the bread with the wheat germ. We enriched the bread with the germ once in a state not crushed and another in a state crushed with the following proportions: 2.5 - 5 - 7.5 - 10 - 12.5 and 15 % . We characterized our samples by carrying out chemical analyses, also we determined the content of gluten also its rheological properties in particular the softening and the extensibility and the realization of a bread making test. With the end we carried out the discussion of the results obtained of which most significant: The incorporation of the germ is acceptable with proportions going up to 5%. The use of the germ in a crushed state is advised in order to avoid the presence of the tasks on the crust of the bread what can obstruct the consumer.

Keywords: Wheat, Flour, Germ, Gluten, Bread

ملخص

العمل المقدم يهدف الي دراسة اغناء الخبز برشيم القمح. قمنا باغناء الخبز برشيم القمح مرة غير مسحوق و مرة مسحوق بالنسب الاتية: 2.5- 5- 7.5- 10 - 12.5 و 15%. اجرينا وصف لعيناتنا وهذا بالقيام بتحليل كيميائية, كما حددنا قيمة الغلوتين, ميزته الريولوجية بخاصة الرخاوة و الامتدادية و اجراء تجربة الخبز. في الاخير عملنا على مناقشة النتائج المتحصل عليها و اهمها: زيادة الرشيم مقبولة بنسب تصل حتى 5% ينصح استعمال مسحوق الرشيم لتفادي ظهور بقع فوق قشرة الخبز مما يزعج المستهلك الكلمات المفتاحية: القمح, الدقيق, الرشيم, الغلوتين, الخبز.

Wheat is one of the major cereals and food ingredients across the world; wheat kernel is composed of bran, germ and endosperm [17].

Algeria is a large country consuming cereals. This fact the cereals constitute the base of Algerian population food mode, they represent the major part of the proteins intake. However, an unbalanced amino profile reduces the biological value of cereal proteins.

To mitigate this protein deficiency, it is necessary to proceed to a supplementation with proteins of good quality.

However, the animal proteins in Algeria, as in the majority of the countries in the process of development, are rare and expensive for the average budgets. Moreover the animal restores in the form of noble proteins only into 6 to 25% of proteins intake. What explains the weak conversion rate of plant proteins on animal proteins, as well as the long duration necessary to this transformation.

The plant proteins, such as those of leguminous are currently inaccessible because of their weak production and of their relatively high cost. To cure this disadvantage, we can try to develop directly in human consumption, the under products plant origin which are rich in noble proteins.

The wheat germ constitutes the ideal solution because of its availability and of its high protein content of good quality. Wheat germ, corresponding to 2-3 % of the total weight of wheat kernel, is almost systematically removed during milling since it adversely affects the keeping and processing quality of the flour [19].

The bread is an important staple food made of wheat flour, salt and yeast, and consumed worldwide [7]. It is most popular and accompanies almost all our meals [6]. Nowadays consumers prefer to eat healthier foods in order to prevent non communicable disease [11].

Optional ingredients can be add to improve processing or to produce specially and novelty breads which often have an increased nutritional value [21]. In this respect, our study relates to the incorporation of the wheat germ in bread making, with an aim of improving the bread nutritional value, particularly its proteins. Our study conduce to establish the influence of wheat germ as an ingredient and to determine the effect of wheat germ on gluten content, rheological characteristics and technological properties of bread.

MATERIALS AND METHODS

Samples

The flour mill of Sidi Ghriss was delivered us the wheat germ that recovered of the refusal sieve n°18 of plansifter.

Our sample presented in the form of yellow flattened flakes, with presence of the remains bran and flour particles.

A sample of flour baker was delivered to us by ERIAD El kharoub.

Wheat germ preparation

Wheat germ purification

The sample required a purification that carried out in two stages:

It was initially to eliminate the flour particles, by means of a sieve with reduced meshes (1mm of section).

In second place, it was question of removing the bran remains, we used sieve with special meshes (takeida).The germ obtained was relatively pure.

The crushing of the wheat germ

Half quantity of the purified wheat germ was cooled at 4°C as a preliminary in order to avoid its heating during crushing; this last was carried out by means of a crusher (mark IKA).

Samples storage

The prepared wheat germ was stored at 4°C, as for the flour was preserved at room temperature.

Chemical analyses

Moisture, flour ash, germ ash, total lipids and protein contents were determined following to standardized method AFNOR NV 03-707, NV 03-720, NV 03-760, NV 03-713 and NV 03-050, respectively [1]. Measurements of the free lipids content was carried out according to sohxlet method [15]. The method of reference practical, consisted to place the samples in capsules underwent desiccation at 130 °c – 133 °c in an oven Chopin. The loss mass observed, was equivalent to moisture content.

The samples flour and wheat germ respectively were incinerated in oxidizing atmosphere in a moufle furnace adjusted at temperature of 900°C and 550°C. Until the complete combustion of the organic matter, the ash content was determined by the weighing of the residue. The determination of total lipids content based on hydrolysis of sample by the hydrochloric acid in the presence of ethanol and the formic acid, thus releasing the lipids related on proteins and the carbohydrates then extraction by hexane; elimination of solvent and weighing of the residue thus obtained.

For the determination of the free lipids content, the samples were placed in paper cartridges, introduced in sohxlet extraction glass tube, this determination was obtained by the exhaustion of free lipids with hexane, which will be then recovered by distillation and weighing of the residue thus obtained.

The bound lipids content was calculated by the following formula:

$$BL = TL - FL$$

BL: Bound Lipids

TL: Total Lipids

FL: Free Lipids

The determination of protein content was based on the determination of nitrogen, according to the method of kjaldahl. The principle was based on a mineralization by the sulphuric acid in the presence of catalyst, alkalisation of the reaction products, distillation of released ammoniac and titration.

The conversion factor of total protein nitrogen for flour and wheat germ was 5.70 and 6.25, respectively. The content of chemistry carbohydrate was deduced by subtraction according to the following formula: [22]. Content of chemistry carbohydrate = 100 - (moisture content + ash content + total lipids content + proteins content) The results presented were the average of three tests.

Our experiments were conducted with utilisation of wheat germ as ingredient, at six levels : 2.5 - 5 - 7.5 - 10 - 12.5 and 15 %.

The determination of the gluten content The Manual gluten extraction

The gluten was extracted manually, on the basis of its insolubility in water, and its capacity to agglomerate under a filament of water. The specific properties of gluten were to form an elastic mass when hydrated.

Gluten Content

The dry gluten content was determined according to Algerian norm NA – 736 n°03-96-09. The principle was based on the desiccation and the weighing of wet gluten ball, in a regulated drying oven at $130 \pm 2^\circ\text{C}$ during 5 hours, with 3 to 4 incisions of the gluten.

To bring back the rate of the wet gluten and the dry gluten to 100g of flour and to calculate the water-binding capacity of the gluten by the following formula:

$$(WG - DG) \times 100 / WG$$

WG: Wet Gluten,

DG: Dry Gluten

Reological Properties

The determination of softening

The determination of softening was carried out according to the method of Krauzes and al.1966 quoted by Cheriet, 2000 [5].

After 60 min, the difference between the two average diameters initial and final give the softening of the gluten (in mm), which value of the softening < 2 mm presented tough and firm gluten, of 2 – 4mm presented gluten of good quality, of 4 – 8 mm presented gluten of average quality and of 8 – 13 mm presented gluten of bad quality.

detremination of extensibility

The appreciation of extensibility was carried out according to the method of Kozmin and kranz described by Jakubczyk et al. 1983 [18]. To attach a gluten pellet to a support in top of a test-tube and to charge it of a weight of 4 g, to place paper millimeter over the length of the test-tube so as to read lengthening on paper. The expression was made at a temperature of 25°C and during 24 h; a very good gluten which keeps its length after 2 H.

Bread making

Bread making was the most objective test of value baker evaluation, consisted to measure volume and to test bread properties

Wheat flour was replaced by combinations of germ at 2.5, 5, 7.5, 10, 12.5 and 15% levels. Dough was prepared by mixing the flour with ingredients (65% of water, 2% salt and 2 % commercial compressed yeast) in a kneader (Santos mark, speed 70 tours/min), submitting to fermentation for 40 min at 30°C , shaping of 100g, before final fermentation for 60 minutes at 30°C , finely the dough was baked at 260°C for 9 min to make bread. The breads were cooled down at room temperature at least one hour. Loaf volume was measured according to the method described by jakubczyk 1983 [18], by displacement of small, light and round seed (couscous).for each measurement; a jar was filled with couscous. Breads were then placed in the jar. The abundant volume of couscous, being equal to the volume of bread, was collected and measured in graduated cylinder.

The crumb density (g/cm^3) was the ratio of a crumb mass, and its volume. The color of bread, form, characteristics of the crust were done visually.

RESULTS AND DISCUSSION

Results of the chemical analyses

Moisture content

The moisture content was significant to know, for to bring back the results of the analyses to a stable base (dry matter), in order to validly confront the results with the standards. A moisture flour content was 12.75 % (table 1), which was relatively dry and suitable for a good storage.

According to work of Rizello & coll [20], the moisture wheat germ was 11.08%. That agrees with the literature where the moisture of the industrial germ was 11.75% [13].

As for our wheat germ sample the moisture was low (table 1), It is 9.72 % and 9.71 % for the crushed germ and the not crushed germ, respectively, this fall can be due to the milling conditions.

Table 1: Flour and wheat germ characterization (% matter dries).

	Moisture	Ash	Lipids			Proteins	carbohydrates
			Total	free	bound		
flour	12.75 ±0.15	0.57 ±0.03	1.60 ±0.02	1.22 ±0.06	0.38 ±0.05	9.10 ±0.10	88.73 ±0.14
NCG	9.71 ±1.50	5.27 ±0.07	9.72 ±0.02	7.97 ±0.62	1.75 ±0.59	32.46 ±0.48	52.55 ±0.14
CG	9.72 ±0.65	5.27 ±0.28	9.78 ±0.01	9.24 ±0.07	0.54 ±0.05	33.13 ±0.30	51.82 ±0.20

Ash content

The amount of ash flour was one of the characteristics of the purity of this one. This determination allowed us to determine the rate of flour extraction [3].

The ash content obtained (0.57 %), makes it possible to classify the flour of the type 55, flour suitable for making bread current [3].

The amount of ash wheat germ (crushed or not) was 5.27 % (table 1). While according to the flour study of Rizello & coll [20], the rate of ash was low, 3.82%.

Lipids content

The lipids content was 1.60%, free lipids constitute a higher share with 76.25% than a bound lipids level which was 23.75 %.

The germ not crushed, had a level of lipids of 9.72 % whose free lipids represent 81.99 %, while the bound lipids represent 18 %.

The lipids content of crushed germ was 9.78 %, where 94.47% are free lipids and 5.52 % were dependent lipids.

We deduced from these results that the majority of the lipids germ was neutral lipids, what agrees with study of Berger [2].

Proteins Content

The amount flour protein was 9.10 % (table 1). The germ was rich in protein; it presents a content of 32.46 % and 33.13 % for the germ not crushed and germ crushed respectively. Rizzello & al., found a rate less raised 28.50 % [20].

Content of carbohydrates

The flour was an energy food; who's its carbohydrate content (table 1) was 88.73 %. The carbohydrate content of germ not crushed and crushed germ was respectively 52.55 % and 51.82 %.

Results of gluten extraction

Gluten was an essential structure building protein that provides viscoelasticity to the dough, good gas-holding ability and good crumb product [9].

The gluten extracted of witness flour was elastic and the yellow colour, the wet gluten content of flour was 26.34 % whereas dry gluten was 9.06 % (table 2)., this result enable us to conclude that this flour was suitable for bread making

The water-binding ability of gluten extracted was 65 % (table 2), this characteristic was in relation to the flour quality, it normally lies between 62-65 %, and can rise to 69 %, and it decreased up to 60% when the extraction rate of the flour was high, or when the aged flour, the flour gives badly raised products [15]. The hydration capacity of our flour sample was 65.60% (table2).

Table 2: Wet gluten content, dry gluten content and the water-binding capacity of flour (% matter dries.)

	Wet gluten content	Dry gluten content	Water-binding capacity.
Witness flour	26.34 ± 0.25	9.06 ±0.08	65.60 ±0.01

Results of the gluten extraction after addition of not crushed germ (NCG)

The gluten extraction of supplemented flour became increasingly difficult; the gluten obtained was elastic with yellow colour.

Wet gluten Content

Wet gluten content of supplemented flour varied from 19.20 % to 23 % which showed the lowest value compared with witness flour (26.34%).

Content of dry gluten

The results (table 3) indicated that dry gluten content decreased by increasing a level of germ supplementation; however the value obtained was acceptable (7.28 % - 8 %) safe for 12.5% the dry gluten amount was low 6.74%.

Water-binding capacity

As for the amount of water-binding capacity of gluten varied from 65 to 66.01 % (table 3), which was similar than the witness flour.

Table 3: The effect of not crushed germ, on wet gluten content, dry gluten content, and on Water-binding capacity (% matter dries).

% NCG	Wet gluten content	Dry gluten content	Water-binding capacity.
0	26.34 ± 0.25	9.06 ± 0.08	65.60 ± 0.01
2.5%	23.00 ± 0.00	8.00 ± 0.00	65.21 ± 0.00
5 %	22.60 ± 0.28	7.68 ± 0.22	66.01 ± 0.66
7.5 %	21.46 ± 0.46	7.48 ± 0.10	65.15 ± 0.25
10 %	20.80 ± 0.00	7.28 ± 0.00	65.00 ± 0.00
12.5%	19.20 ± 0.00	6.74 ± 0.02	64.89 ± 0.02
15%	Difficult Extraction	Difficult Extraction	Difficult Extraction

NCG: Not crushed germ.

Results of the extraction of the gluten after addition of crushed germ

The extraction of the gluten, after crushed germ incorporation, gave a gluten which agglomerates increasingly difficult, elastic and of yellowish color.

Content of wet gluten

The wet gluten contents obtained after addition of crushed germ located between 17% and 22.90%, and they were lower than the witness flour (26.34%).

Content of dry gluten

The dry gluten contents obtained of flour supplemented by crushed germ located between 7.43-8.20 % that was recommended of bread making. However, at the addition of 12.5 % the dry gluten content was low 6%.

Water-binding capacity

The Water-binding capacity of the gluten, after addition of crushed germ ranged between 64-64.70%.

Conclusion of the gluten extraction results

Wet gluten content decreased after addition the germ wheat (crushed or not) (figure 1), also for the content dry gluten (figure 2). The two curves represented on figure 1 and on figure 2, were almost confused, the size of the germ does not have an effect on the gluten content.

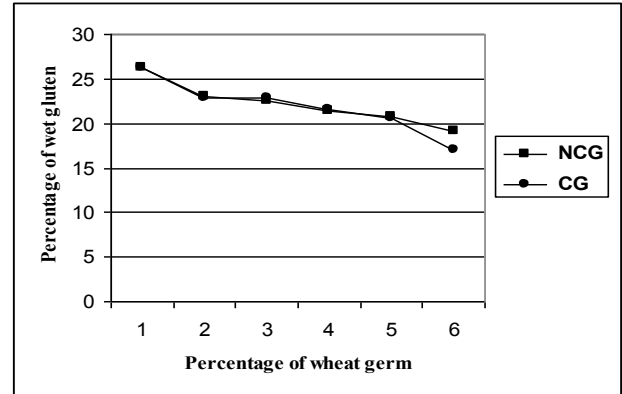


Figure 1: Wheat germ influence on wet gluten content

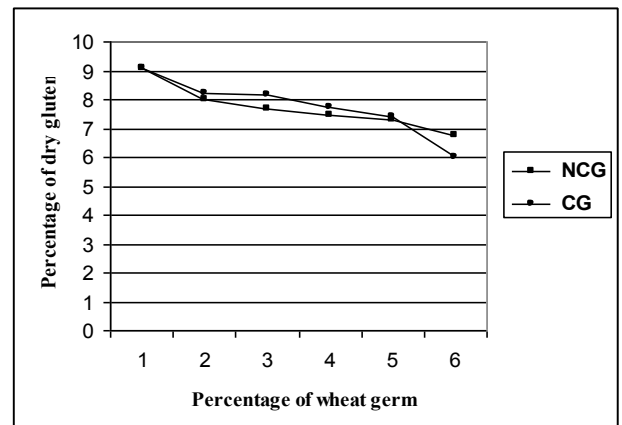


Figure 2: Wheat germ influence on dry gluten content

The dry gluten contents of supplemented flour, at 2.5 %, 5%, 7.5% and 10 % levels germ (crushed or not) located between 7-11%, however at the proportion of 12.5 % the dry gluten content was at the lower part of 7%.

The addition of the wheat germ in bread making influences the gluten content what was due to a reduction in its cohesion. This effect was probably due to the action of the lipids, which have a depressive effect by decreasing physical cohesion of the colloidal complex that the gluten constitutes, [13]

Results of the rheological analyses

The result of the softening showed that spreading out of the gluten was 6.33 mm which qualified it of average quality.

The gluten extracted of witness flour lengthens up to 0.53 cm, which qualified it of good gluten.

Not crushed germ addition

Softening

The results found that softening of gluten increase by the degree of not crushed germ supplementation; they range between 7.83 % - 8.66 %. At 2.5 %, 5 % and 7.5 % levels, the gluten quality was average, whereas, for 10 % and 12.5 % addition the gluten quality was bad (table 4).

Table 4 : Effect of germ not crushed on gluten softening and extensibility

%NCG	Softening (mm)	Extensibility (cm)
0%	6.33 ± 0.57	0.53 ± 0.05
2.5%	7.00 ± 0.50	0.53 ± 0.05
5 %	7.83 ± 0.28	1.06 ± 0.15
7.5 %	7.83 ± 0.28	0.76 ± 0.32
10 %	8.66 ± 1.69	0.83 ± 0.40
12.5%	8.50 ± 0.61	2.00 ± 0.00
15%	-	-

NCG: not crushed germ

Extensibility

Gluten extracted of supplemented flour at 2.5-5-7.5 and 10%, levels lengthen less than 1.5 cm, and keep this length during 2h. The gluten was of good quality.

Their extensibility ranges between 0.53 and 1.06 mm (table 4). Whereas to 12.5% not crushed germ, the gluten extensibility was 2 mm, it is thus qualified like soft gluten

Crushed germ addition Softening

The softening of gluten increased after crushed germ addition (table 5).

Table 5 : Effect of germ crushed on gluten softening and extensibility

%CG	Softening (mm)	Extensibility (cm)
0%	6.33 ± 0.57	0.53 ± 0.05
2.5%	7.71 ± 0.28	0.50 ± 0.00
5 %	8.00 ± 0.50	0.60 ± 0.11
7.5 %	8.00 ± 0.00	0.56 ± 0.04
10 %	8.20 ± 0.07	1.30 ± 0.00
12.5%	8.83 ± 0.57	2.10 ± 0.00
15%	-	-

CG: Crushed germ

The results showed that the glutes obtained after addition of 2.5%, 5% and 7.5% crushed germ have a softening ranging between 7.71-8 mm, which makes it

possible to qualify them like glutes of average quality. After addition of 10% or 12.5% crushed germ, the spreading out of the glutes obtained range between 8-13 mm. These glutes were of bad quality.

Extensibility

The results of the extensibility of the gluten after addition of the crushed germ (table 5), enable us to classify the glutes as follows:

- At 2.5%, 5%, 7.5% and 10% crushed germ level; the extracted glutes had a lengthening ranging between 0.50-1.30 cm. These glutes were of good quality.- At addition of 12.5% crushed germ, the gluten was spread out 2cm, which qualify it as soft gluten.

conclusion of the rheological analyses

The softening of gluten extracted after wheat germ supplemented flour, increased for all levels. Either crushed or not crushed germ, the gluten extracted of supplemented flour, was of average quality until 7.5 % addition, whereas with the proportions of 10% and the 12.5% glutes were of bad quality.

As for extensibility, until 10% wheat germ (crushed or not), the gluten extracted was of good quality, beyond that the gluten was of soft quality.

The softening and the extensibility of the gluten can probably be influenced by the effect of the soluble proteins, which had the possibility of modifying the balance of the bonds disulfures, which ensure the solidity of the glutinous network [8] and thus generates its weakening. However, the proteins germ are water soluble of leaching, thus of other components of germ, can influenced the rheological properties of the gluten, in particular the lipids which make discontinuous the network of the gluten, and return it more coward.

bread making results

Bread making results carried out of witness flour gave bread developed well, with a volume of 321cm³ and weight of 80g, the bread presented a gilded colour and pleasant taste.

As for crumb obtained, was alveolate; characterised by a light density, 0.23g/cm³.

This result showed that the flour has an acceptable baker value, in more than the results relating to the rheological properties of the gluten predispose it for the bread making.

That shows the gluten importance in the communication to the paste of the plastic properties [3]. In the same way, that one of the gluten properties is its aptitude to form a strongly cohesive and viscoplastic paste, which constitutes

the base of the transformation of wheat flour into paste baker, and later conversion into bread by fermentation and cooking [4].

Test results of bread making after addition of wheat germ

The modifications which make the addition of the germ not crushed and of the crushed germ was represented in tables 6 and 7 respectively.

Paste characteristics

Either crushed or not crushed germ, at 5, 7.5, 10, 12.5 and 15 % incorporation, the paste becomes little extensible and little elastic with cream color and a presence of germ tasks.

At 2.5% the germ addition, the paste was extensible, elastic and of white color with however, presence of some germ tasks.

Table 6: Test results of bread making after addition of not crushed germ

Pate characteristics	Color	Crumb density g/cm ³	Crust aspect	Bread forme	Bread color	Loaf volume cm ³	
Extensible Elastic White	White	0.23 ± 0.04	crusty fine	Round	Normal	321.6 ± 3.30	0% GNB
Extensible Elastic White +YCS	White	0.33 ± 0.08	crusty fine	Round	Normal	268 ± 21.75	%GNB2.5
Little extensible Little elastic White cream YCS+	White cream +CS	0.33 ± 0.04	crusty fine	Round	Normal+ RS	± 12.48246.5	5%GNB
Little extensible Little elastic White cream YCS+	White cream +CS	0.40 ± 0.03	crusty fine	Punt (+)	Normal+RS	13.58217 ±	7.5%GNB
Little extensible Little elastic Cream + YCS	Cream +CS	0.46 ± 0.03	crusty fine	Punt (+)	Red (+)	17.63200 ±	10%GNB
Little extensible Little elastic Cream + YCS	Cream +CS	0.43 ± 0.04	crusty fine	Punt (++)	Red (+)	9.25 190 ±	12.5%GN B
Little extensible Little elastic Crème + YCS	Cream +CS	0.47 ± 0.05	crusty fine	Punt (++)	Red (++)	9.73188.5 ±	15%GNB

NCG: Not crudhed germ- **RS:** Red spot –**CS:** Cream spot-**YCS:** Yalow cream spot

Table 7 : Test results of bread making after addition of crushed germ

Paste characteristics	Color	Crumb density g/cm ³	Crust aspect	Bread forme	Bread color	Loaf volume cm ³	%CG
Extensible Elastic White	White	0.23 ± 0.04	Crusty fine	Round	Normal	321.6 ± 3.30	0
Extensible Elastic White + SYS	White	0.22 ±0.04	crusty fine	Round	Normal	286 ± 17.12	2.5
Little extensible Little elastic White cream + SYS	White cream	0.35 ±0.06	Crusty fine	Round	Normal	242.5 ± 18.44	5
Little extensible Little elastic cream + SYS	cream	0.32 ±0.07	crusty fine	Punt (+)	Normal	227 9.48 ±	7.5
Little extensible Little elastic Cream gray + SYS	Gray cream	0.45 ±0.05	Crusty fine	Punt (+)	Red (+)	206 ± 12.48	10
Little extensible Little elastic Cream gray + SYS	Gray crea	0.45 ±0.06	crusty fine	Punt (++)	Red (+)	197 ± 4.21	12.5
Little extensible Little elastic Cream gray + SYS	Gray cream	0.51 ±0.06	crusty fine	Punt (++)	Red (++)	183.5 ±12.25	15

CG: Crushed germ – SYS: Small yellow spot

Loaf volume

The loaf volume significantly decreased after germ incorporation either crushed or not; and it hadn't a significant difference between volume bread obtained of crushed germ and those obtained with not crushes germ

The loaf volume depends on dough expansion and ability of the matrix to stretch before it reapture and limit of expansion [23].

The decrease of loaf volume was probably due to the germ constitutes, in particular its neutral lipids, which decrease a loaf volume [2]. According to Cheptel, (1985) the protein germ depress the swelling of the paste and give also a volume of the insufficient bread [4].

The incorporation of the wheat germ in bread making reduced the volume of the bread, but at the weak rates of addition in particular 2.5 % and 5% the breads obtained have an acceptable volume compared to the other rates.

Generally, volume bread depends on gas formation, which depends on many factors such as yeast, fermentable sugars, baking powder and pH, and gas retention which is affected by fiber content. The non endosperm components (germ, bran, and epicarp hairs) are know to be responsible for producing the low and dense crumb texture of whole bread [10].

Organoleptic characteristics

The color

The color of the crust was the resultant of caramelization and Maillard reaction [16].

The result showed that the breads color was gilded to 2.5 % not crushed germ, whereas, at 5% and 7.5 % incorporation rates, the color presents red spot and it becomes increasingly red at the other rates incorporation.

The breads color obtained with 2.5%, 5% and 7.5% crushed germ had a homogenous gilded color. Whereas those obtained at 10%, 12.5% and 15% had an increasingly red color.

The breads red color observed was probably due to the germ incorporation. Sometimes according to Calvel, (1984), the crust color can take another color than the gilded, it can redden, and we are in the presence of an abnormal color. An extraction high rate can be then the cause [3].

Crust characteristics are decisive for the purchasing attitude of consumers of bakery product, which is based on the subjective sensory perception [14], in this fact, we noted that the crushed germ incorporation was preferable at low levels in bread making than not crushed germ, so that the breads obtained had a homogeneous color without presence of the tasks which can obstruct the consumer.

The form

At 2.5% and the 5% not crushed germ, the bread obtained was of round form and crusty, while those obtained at another rates were punt forms.

The wheat germ is thus the cause of the bad development of the bread.

Characteristics of the crumb

The crumb density increased progressively after germ incorporation, crushed or not. The crumb obtained after addition of 15% germ, was less porous and heaviest with 0.51 g/cm³ and 0.47 g/cm³, crushed and not crushed germ, respectively.

According to Calvel, (1984). Porosity depends not of gluten quantity, but rather of its quality [3]. It depends especially of fermentable sugars quantity, and yeast activity [13]. Descriptive sensory attributes have been reported for discriminating among different bread types [12].

CONCLUSION

The aim of this study was the influence of the wheat germ incorporation in bread making.

This study enabled us to note that the incorporation of wheat germ involved a fall of the content of wet and dry gluten; however at the rate of addition going up to 10%, the dry gluten content was in the standards norms, and beyond, it became inferior to 7%, whereas the water-binding capacity of gluten remains unchanged.

Results of the gluten rheological analyses, allowing to note that the gluten softening increased with the wheat germ supplementation. The gluten quality was average with lower rates to 10% and was bad to 12, 5%.

As for the results of extensibility, they qualify us the gluten of good quality for the rates of addition going up to 10% and it becomes soft for 12.5%.

In the last, the test of bread making which enabled us to judge the bread quality:

The incorporation of the wheat germ decreased the bread volume. The bread characteristics obtained after addition of wheat germ were acceptable until 5% levels supplementation.

Although, the influence of not crushed germ incorporation in bread making was the same one as in a crushed state, however the breads enriched with crushed germ had a color more homogeneous than those enriched with not crushed germ, which is also preferable by the consumer. The study already to carry out should be to accomplish by alveographic tests in order to examine the effect of the wheat germ addition on the elastic properties of dough.

we can recommend, to incorporate the wheat germ in bread making by using either a flour of strong value baker, or the semolina in order to minimize the wheat germ effect on the technological quality of the bread (in particular volume).

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