

## DEVELOPMENT OF COMPOSITE PASTA BETWEEN WHEAT AND BARLEY: TEST OF THE INCORPORATION OF BARLEY FLOUR INTO COMMON WHEAT FLOUR FOR THE FABRICATION OF A COOKIE

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### Résumé

Ce travail est un essai d'incorporations de farine d'orge, à différents pourcentages, à de la farine de blé tendre, afin de produire un biscuit. Il consiste en la production d'un cookie témoin (avec de la farine de blé tendre) et le mélange de biscuits à différents pourcentages d'orge. L'incorporation de 25% d'orge a finit par rendre difficile de mélanger la pâte, de la laminer et de la mettre en bac car la pâte devient sans cohésion. La description de la fabrication a conduit à l'établissement d'un diagramme de fabrication. Les tests de dégustation ont indiqué que le biscuit témoin et le biscuit contenant 5% d'orge sont presque identiques et présentent de bonnes caractéristiques organoleptiques. Les biscuits contenant 10%, 15% et 20% d'orge présentent une couleur foncée et une croûte dure et rugueuse. Des dosages chimiques de matières premières et de produits finis ont également été effectués. Les densités nutritionnelles (ND) et les densités énergétiques (ED) ont augmenté avec le pourcentage d'incorporation de la farine d'orge.

### Abstract

This work is an essay of incorporations of barley flour, at different percentages, to soft wheat flour, in order to product a cookie. It consists to a production of a witness cookie (with soft wheat flour) and mixture cookies at different percentages of barley. The incorporation of 25% of barley end up by the difficulty to mix the paste, to laminate it and to put it in tray because the paste become without cohesion. The description of fabrication led to establishment of a fabrication diagram. Tasting tests indicated that the witness cookie and the cookie with 5% of barley are almost identical and present good organoleptic characteristics. Cookies with 10%, 15% and 20% of barley present a dark color and a hard and rough crust. Chemical dosages of raw material and finished products have also been done. Nutritional Densities (ND) and Energetic Densities (ED) increased with the percentage of barley flour incorporation.

**Keywords:** wheat, barley, mixture paste, cookie, fabrication diagram, tasting tests, chemical analysis.

### ملخص

يتمثل هذا العمل في محاولة إضافة فرينة الشعير بنسب مختلفة الى فرينه ال قمح اللين لصناعة بسكويت، ويشمل تشكيل بسكويت شاهد (بفرينة القمح اللين) وبسكويت مزيج شعير . انتهت اضافة 25% من الشعير بصعوبة خلط العجينة و طرحها ووضعها في صينية الفرن، لان العجينة تصبح غير متجانسة وغير قابلة للمزج . وصف مراحل التشكيل أدوات مواد اولية وعمليات ( ووضع مخطط الصنع. بينت إختبارات التذوق ان البسكويت الشاهد وبسكويت 5% شعير متطابقين تقريبا ولديهما خواص جيدة، اما بسكويت 10,15% وخاصة 20% فلها لون داكن وقشرة صلبة يابسة وبين حساب الكثافات الغذائية و الطاقوية أنها ترتفع بارتفاع نسبة الشعير المضافة.

الكلمات المفتاحية : قمح- شعير- عجينة مزيج- بسكويت- مخطط الصنع- تجارب التذوق- تحاليل فيزيوكيميائية

Wheat plays a leading role in the grain sector because of the rapid growth of the urban population and the inability to organize food self-sufficiency in the poorest wheat-importing countries. The use of compound meal appeared to be a preferred way to value local cereals, to provide farmers with an income similar to cash crops, to reduce wheat imports and to improve nutrition. For years, research programs have been launched by various countries using sorghum, maize, millet and tubers such as cassava, yams to make, often mixing with wheat flour, bread, cookies, pasta or weaning foods (Godon et Willm 1991). Many countries have successfully developed national breadmaking programs from these flours, also known as substitute flours (Feinberg *et al.* 1992, Pozrl *et al.* 2009). In cookie making, formulas in which 50% of wheat flour was replaced by other cereals were developed, while keeping to the dough a sufficient plasticity for a continuous mechanization of a production of molded or cut cookies (Netherlands).

The search for the use of barley in the human diet is still limited because of its impenifiable nature. Barley flour is used in bakery, but at a low percentage: 20 to 30% (Kiger et Kiger 1967). Unlike wheat, barley contains tiny amounts of gluten. Barley paste is friable and loose and breads made from barley grains are heavy and dense, but very nutritious (Jestin 1989). The flour obtained by the grinding of barley seeds is therefore unsuitable for bread-making (absence of gluten) if it is used alone. It is without any cohesion during cooking. It must therefore be mixed with a quantity of wheat flour or semolina. Thus, barley could be valued by its use in the manufacture of so-called composite pasta.

Cookies are cereal foods of a very wide variety of presentation and tastes. Their intake of complex carbohydrates is interesting. In addition, they can complement other foods. There is such a variety of cookies, it is preferable to refer to the following definition: the cookie is a food based on flour, fat, sweetening material and any other food product: fragrances and condiments authorized, susceptible after cooking to retain their organoleptic and commercial quality for a period longer than one month (Mohtadji-Lamballais 1989).

The present work consists of incorporating barley flour, at different percentages, in soft wheat flour for the manufacture of a cookie. The objectives of this study are as follows :

- Formulation of a control cookie (made from wheat flour) and composite cookies (5, 10, 15 and 20% barley)

- A description of manufacture (utensils, raw materials and operations) and completion of the production diagram
- Tasting tests
- Dosages of major nutrients (moisture, ash, total lipids, total nitrogen and total carbohydrates) of raw materials and finished products
- Calculations of nutritional and energy densities

## MATERIAL AND METHODS

A soft wheat flour that we bought at the store was used in the present study. The sample is stored in a paper bag. The barley flour that was used to make the cookies was prepared at the laboratory. The barley used (Saida variety) was milled and screened in a 300  $\mu\text{m}$  sieve for a few days before use (It is the particle size of a standard sieve used to sift flour). The sample is stored in a plastic bag. We used in our work the ordinary sugar which is sucrose. The fat used is a vegetable margarine. A whole egg was used for each test.

- 1- **Dosing of moisture** : Moisture is dosed by a moisture meter. The latter allows rapid dosing of moisture. It works according to the principle of hot drying (130 °C).
- 2- **Ashes dosing** : The ash content was determined according to the method described by the standard AFNOR-NF.V03-720 (AFNOR 1986). It consists in incinerating a test portion of 5 g, in a muffle furnace set at 900 °C for 2 hours. The ash content is determined by weighing the resulting residue.
- 3- **Protein dosing** : The KDJELDAHL method is formally designed for the determination of the nitrogen content according to the norm AFNOR V03-05 (AFNOR 1991). The protein content is determined from the total nitrogen content multiplied by the conversion factor 5.7 for cereals (Godon 1991a).
- 4- **Determination of total lipids** : The total fat content and all the substances extracted by hexane under specific operating conditions are expressed as a percentage by mass of the product as such analyzed (AFNOR 1986).
- 5- **Total carbohydrates** : The total carbohydrate content is calculated by difference: 100 - (moisture + proteins + lipids + ashes).
- 6- **Number of tests and calculations of means and standard deviations** : Each analysis was subjected to three trials, the results obtained were used to calculate the mean and the standard deviation.
- 7- **Energy density** : For the determination of energy density, we used the Atwater coefficients (1896) :

- 4 kcal/g of total proteins,
- 4 kcal/g of total carbohydrates,
- 9 kcal/g of total lipids.

8- Sensory evaluation : The organoleptic examination of the cookie is performed two hours after the removal. The appreciation of the cookies obtained was carried out by a jury composed of 8 tasters. The test is focused on :

- External appearance (surface condition, cracking, texture)
- Internal appearance (color, hardness, presence of alveoli)
- Flavor (odour, taste).

The different cookies were coded as follows (Visual appreciation and according to the literature) :

1: 10% barley cookie, 2: 20% barley cookie, 3: 5% barley cookie, 4: 15% barley cookie, 5: control cookie.

## RESULTS AND DISCUSSION

1- Results of physicochemical analyzes of soft wheat flour : The results of the physicochemical analyzes of common wheat flour are shown in Table 1.

**Table 1:** Results of physicochemical analyzes of soft wheat flour

	Hum	Ash	Pro	Lip	Car
Content (%)	14.16	0.54	7.44	1.24	76.62
	± 0.24	± 0.06	± 0.23	± 0.19	

Hum : Humidity, Ash : Ashes, Pro : Proteins, Lip : Lipids, Car : Carbohydrates

1-1- Humidity : The value obtained corresponds to the standards described by Calvel (1984) which recommends values in the range 14-16% for humidity content.

1-2- Ashes : The result obtained meets the criteria of a flour intended for cookie making, that is to say at a content which does not exceed 0.75%.

1-3- Total lipids : The total lipid content meets the standards set for flour for cookies, which are 1.20-1.40%.

1-4- Proteins : The protein content meets the standards set for cookie flour, which is 7 to 9%.

1-5- Carbohydrates : The content corresponds to a high content compared to the standard described by Selselet-Attou (1991) which is between 60-72%.

2- Results of physico-chemical analyzes of barley flour : The results of physico-chemical analyzes of barley flour are given in Table 2.

**Table 2:** Results of physicochemical analyzes of soft wheat flour

	Hum	Ash	Pro	Lip	Car
Content (%)	12.25	2.43	5.44	3.49	76.39
	± 0.24	± 0.17	± 0.23	± 0.07	

Hum : Humidity, Ash : Ashes, Pro : Proteins, Lip : Lipids, Car : Carbohydrates

2-1- Humidity : The value obtained is within the range of values described by the ITCF (1995)

2-2- Ashes : The result obtained is in accordance with the standard described by Scherz *et al.* (1986) cited by Himeur and Kouahi (2003). The ash content of barley flour is higher than that of wheat. This results from the presence of sound debris. According to Selselet-Attou (1991), the lower the extraction rate, the lower the ash content and vice versa.

2-3- Total lipids : The total lipid content meets the standards given by Jeantet *et al.* (2007) which indicates that the average lipid content is of the order of 2-3.5%. This is mainly due to the presence of the germ which is rich in fat.

2-4- Proteins : Protein content may depend on varietal and agro-climatic factors that can increase values by 1 to 2% (ITCF 1995). Our result is not in the range of 9.5-11.5% announced by Jeantet (2007).

2-5- Carbohydrates According to Jeantet *et al.* (2007), the proportion of carbohydrates is between 75 and 78%. Our result is included in the standard cited above.

## 3- Process of making cookie

3-1- Formulation of the cookie : For the manufacture of our cookie, we proceeded to the application of the following recipe (This is the specific recipe of our laboratory) :

- Flour ..... 250 g
- Butter ..... 125 g
- Sugar ..... 62.5 g
- baking powder ..... 2.5 g
- Egg ..... 1 egg

3-2- **Incorporation tests** : We did 4 trials of incorporating barley flour into wheat: 5, 10, 15 and 20% barley. We made the following observations:

- Whenever we have increased the barley incorporation rate, the dough cohesion gradually decreases. It reaches its maximum at 20% barley. At 25% barley, the dough becomes difficult to mix, to mine and to put in tray
- Cooking time for cookies is longer as the barley incorporation rate increases. This time is about 1 hour for the cookie at 20% barley.

3-3- **Preparation of the mixture** : This operation aims to mix the raw materials by transforming them into a homogeneous paste. The operation is as follows:

- Mix of fat and sugar. This mixture is done manually until total dissolution of the sugar (10 minutes)
- Addition of the other ingredients (egg, yeast) with a continuous mixing each time we add an ingredient until homogenization (5 minutes)
- Incorporation of the flour by fraction (wheat flour for the control cookie and wheat / barley mixture for the composite cookies) until obtaining a soft dough (8 minutes)

The formed dough will undergo a rest period of 3 minutes.

3-4- **Rolling** : Rolling is the first operation of shaping the dough. This operation brings the dough to the desired regular thickness (5mm). Spreading the dough is done on the bench with a wooden roller.

3-5- **Cutting** : The purpose of the cutting is to split the rolled dough into regular pieces of appropriate shape. A plastic cookie cutter was used.

3-6- **Cooking** : The cooking of the cut pieces is done at a temperature of 180 °C for a time of 12 minutes with an increase of the cooking time with the increase of the barley rate incorporated.

3-7- **Cooling** : After cooking, the cookies are cooled to room temperature of the laboratory

3-8- **Packaging** : The cookies are kept in plastic bags to avoid the risk of breakage, the intake of moisture and keep the product in good hygienic condition.

4- **Organoleptic characteristics of cookies before and after addition of barley** : The results were established after 8 tasting tests. The organoleptic characteristics of the cookies are shown in Table 3.

**Table 3:** Organoleptic characteristics of cookies before and after addition of barley

Sample		Control cookie	5% barley cookie	10% barley cookie	15% barley cookie	20% barley cookie
External appearance	Surface state	No tasks	No tasks	Presence of tasks	Presence of tasks	Presence of tasks
	Cracking	Absence	Absence	Presence	Presence	Presence
	Texture	Regular	Regular	Regular	Irregular	Irregular
Internal appearance	Color	Cream	Cream	Slightly dark	Dark	Darker
	Hardness	Tender	Tender	Hard and crisp	Hard and crisp	Hard and crisp
	Alveoli presence	Tight	Tight	Airy	Airy	Airy
Flavor	Smell	Good	Good	Pleasant	Pleasant	Pleasant
	Taste	Sweet	Little sweet	Little sweet	Little sweet	Less sweet

**4-1- External appearance**

- Surface state : The 5% barley cookie keeps its surface state identical to that of the control cookie. On the cookies with 10, 15, 20% of barley, there was appearance of white spots.
- Cracking : Cracking appears from 10% barley incorporated.
- Texture : From 15% barley, the appearance becomes irregular because the dough becomes more and more friable.

**4-2- Internal aspect**

- Color : There is an accentuation of the color of the cookies after addition of the barley of the cream color (cookie and cookie with 5% barley) to a light cream color (cookie with 10% of barley) then with brown (cookie 15% barley) and finally dark brown for the cookie 20% barley
- Hardness : The control cookie and the 5% barley cookie are tender, while from 10% barley, the cookies are hard, but crispy
- Alveoli presence : The control cookie and the 5% barley cookie are tight (poorly aerated). From 10% barley, there is good aeration (appreciated visually, by dividing a piece of biscuit in half)

**4-3- Flavor**

- Smell : The control cookie and the 5% barley cookie have a good smell. From 10% barley, the smell becomes less and less pleasant
- Taste : There is a decrease in the sweetness of cookies with the increase of the incorporation rate. The cookie has a sweet taste but from the first incorporation (5% barley), the cookie becomes unsweetened, up to 20% barley where the cookie becomes less sweet.

5- Results of physicochemical analyzes of the various cookies : The results of the physico-chemical analyzes of the different types of cookies are mentioned in Table 4.

**5-1- Control cookie**

- Humidity : The moisture content is close to the value of 2% described by Favier et al. (1995)
- Ashes : The ash content is lower than that described by Favier et al. (1995) and which is 3%. This content may be due to the low ash content of the flour which is 0.55%
- Proteins : The protein content is close to that described by Favier et al. (1995) and which is 7%.
- Lipids : The value is higher than that described by Favier et al. (1995) and that is 20%
- Carbohydrates : The value of carbohydrates is close to that described by Favier et al. (1995), which is 68%

5-2- Cookie with 5% barley : We note that there is a slight decrease in the moisture content of the 5% barley cookie compared to the control cookie. Protein and carbohydrate levels have also decreased. On the other hand, there is an enrichment in lipids

5-3- Cookie with 10% barley : There is also a slight decrease in moisture content, protein, carbohydrate, with an increase in fat content compared to control cookie and cookie at 5%

5-4- Cookie with 15% barley : There is a decrease in carbohydrate, protein and moisture content. On the other hand, there is an increase of the lipid and ash content compared to the control cookie and the composites 5% and 10%

5-5- Cookie with 20% barley : There is a slight decrease in moisture, protein, fat and carbohydrate content and an increase in ash content compared to the control cookie and the 5, 10 and 15% composites.

**Table 4:** Results of physico-chemical analyzes of different types of cookies

	Humidity %	Ashes %	Proteins %	Lipids %	Carbohydrates %
Control cookie	1.77 ± 0.05	0.84 ± 0.02	5.68 ± 0.32	26.37 ± 0.68	65.34
5% barley cookie	1.17 ± 0.09	0.89 ± 0.05	5.18 ± 0.16	29.36 ± 1.16	63.40
10% barley cookie	1.46 ± 0.19	0.91 ± 0.02	5.04 ± 0.12	28.74 ± 0.12	63.85
15% barley cookie	1.30 ± 0.23	0.94 ± 0.04	4.83 ± 0.16	30.80 ± 0.17	62.13
20% barley cookie	1.41 ± 0.08	1.10 ± 0.10	5.04 ± 0.12	27.95 ± 0.04	64.5

These results show that there are differences in the major nutrient compositions between the different products based on the wheat / barley mixture:

- There is an increase of the lipid content with the increase of the incorporation rate due to the richness of the barley meal in lipids
- There is a gradual decrease in the protein content with the increase in barley incorporation rate. This decrease can be explained by a protein denaturation under the effect of the cooking temperature
- Control and composites cookies are classified in the category high fat cookies (17-36%) according to the standards described by Fredot (2005).

5-6- Calculation of energy densities and nutritional densities of finished products : The results obtained from our assays are presented in Table 5.

## CONCLUSION

We first proceeded to the formulation of a cookie made from soft wheat flour (control cookie) and composites cookies (based on wheat / barley). We made four attempts to incorporate barley flour into that of soft wheat. The cohesion of the dough decreases with the rate of incorporation of barley. At 20% barley, the dough becomes difficult to mix, roll and set. The cooking time is lengthened with the increase of the rate of incorporation of barley and which arrives until about one hour for the cookie with 20% of barley.

We proceeded to a description of manufacture (utensils, raw materials and operations). Physicochemical analyzes allowed the determination of the major constituents (total proteins, total lipids, ashes, moisture and total carbohydrates) of the cookies. We also calculated energy and nutrient densities.

**Table 5:** Energy Densities and Nutritional Densities of Finished Products

	Energy density (kcal/100g)	Protein density (ND in g/100 kcal)	Lipid density (ND in g/100 kcal)	Carbohydrate density (ND in g/100 kcal)
Control cookie	545.44	1.04	4.83	11.97
5% barley cookie	538.56	0.96	5.45	11.77
10% barley cookie	534.22	0.94	5.37	11.95
15% barley cookie	545.04	0.88	5.65	11.39
20% barley cookie	529.71	0.95	5.27	12.17

According to Table 5, we observe :

- An increase in the energy density of composite cookies in proportion to the increase in barley incorporation rate compared to the control. This is due to the increase in the lipid content which are important sources of energy
- Nutritional density increases with increasing barley incorporation rate. This increase results from the addition of energetic substances such as the egg which is rich in protein and the butter which is rich in lipids, and the richness of the barley meal in lipids
- All cookies (control and composites cookies) are classified as high fat cookies (500 kcal), according to the standards described by Fredot (2005).

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