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Improving nutritional value of pasta enriched with wheat bran

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Abstract

The aim of the present study is to introduce the wheat bran (*Triticum*), at different incorporation rates (10, 15, 20 and 25 %), in local pasta, in order to obtain fiber *aestivum* enriched products. For this purpose, nutritional, sensory and microbiological characteristics of pasta were analyzed. The results obtained revealed that pasta had a satisfying nutritional and technological quality. The Sensory characteristics and cooking quality of pastes as well as their nutritional quality were evaluated and compared to the control sample free of wheat bran. In general, an increase of optimum cooking time, swelling index and water absorption was induced by incorporating wheat bran in experimental pasta. Pasta enriched with wheat bran showed a dark color, especially with incorporation rates 20% and 25%. Whatever the incorporation rate, all pasta revealed high nutritional value compared to the control, with the exception of the dark color. Finally, this study showed the possibility of elaborating pasta enriched with wheat bran, which is mainly used as animal feed. This incorporation allowed enriching the pasta in complex carbohydrates, protein, fat and minerals, without greatly changing the sensory properties.

Keywords: dietary fiber, wheat bran, Pasta, cooking quality, nutrition properties, sensory evaluation.

1. Introduction

The interest in the development of dietary fiber enriched foods has increased significantly due to the awareness about health of consumers and food industry [1]. In recent years in Algeria, research has been conducted on the role of the fraction of "fibers" and focused on the effects of dietary fiber in human pathology [2, 3]. The Interest on cereal fiber due to their important physiological role is growing increased in order to produce high functional quality pasta from unconventional raw materials [4]. Nowadays, the introduction of dietary fiber in food pasta is a relatively easy, convenient and inexpensive operation.

Thus, to preserve the nutritional qualities, several studies have been conducted and considering either, whole grain foods or implementing the re-incorporation of bran in food products [5]. It is clear that pasta is usually made from wheat semolina, but more recently, other cereals were used to partially replace it [6-8].

However, pasta rich in fibers, in essential micronutrients and with low glycemic index components may be preferred by the consumers, in so far as the pasta products are generally high in starch but low in dietary fibers, minerals, vitamins and phenolic compounds. Indeed, Consumers are increasingly interested in foods containing health-promoting ingredients due to their benefits associated to satiety, digestion, weight management and obesity prevention [9]. In other studies, a particular attention has been given to the use of wheat bran, wheat germ and whole-wheat grains in pasta matrices [10-13].

The aim of this study was to determine the possibility of producing wheat bran enriched pasta in order to obtain high quality functional foods. It is further to determine the impact of wheat bran dietary fiber on pasta quality.

2. Materiel and methods

2.1. Raw materials

Triticum durum pasta semoulina was procured from local market with a mean particle size of 250 ± 5 µm for

manufactured pasta. Its composition was: protein 12 g/100 g, carbohydrate 73 g/100 g, ash 0.74g/100g, moisture 13 g/100 g. *Triticum aestivum* bran (52 g/100 g dietary fibre, moisture 14g/100g) was obtained from Moulin Sidi Rabah (SIM/ Semoulerie Industrielle de la Mitidja, Algeria).

2.2. Pasta processing

Wheat bran was incorporated in pasta at different rates (10, 15, 20 and 25 %) to study its impact on the technological quality of the finished product and identify the optimum incorporation rate. Each blend (3 kg) was mixed for 10 min in order to ensure uniform mixture of semolina and wheat bran. The conditions applied were the following: water temperature 50 °C, dough moisture content 36, 34, 32 and 29 g/100 g and mixing time 10 min according to the manufactures guidelines. The format of the pasta (small type, 5.75 mm diameter of die hole) was obtained by using a fresh pasta machine. The samples were dried at 80 °C for 4 h in Drier. Control sample (0 % of wheat bran) was prepared, for comparison, using exclusively durum wheat semolina.

2.3. Pasta analysis

The properties that define the quality of pasta are determined through their cooking quality (Optimum cooking time, Swelling index, disintegration coefficient, cooking water aspect and holding of cooking pasta), their nutritional and microbiological properties, and the sensory evaluation [14].

2.3.1. Pasta properties analysis

Optimum cooking time (OCT) for each type of pasta was determined according to [15]. The cooking test was performed for each pasta sample in various cooking times in order to determine the optimum cooking time (OCT) and to visually determine the aspect of cooking water and the cooking pasta holding. Swelling index (SI) of cooked pasta (g water/g dry pasta) was determined according to the procedure described by [16]. Pasta (10 g) was weighed after cooking and dried at 105 °C to a constant weight. The swelling index was expressed as:

$$SI = (Wc - Wd) / Wd$$

where Wc is weight of cooked pasta (g) and Wd is weight of pasta after drying (g).

To better understand the swelling index, water holding capacity and water retention capacity of wheat bran were both studied using the principles of the Enslin–Neff device [17].

2.3.2. Nutritional properties

Pasta was analyzed for moisture **(**NF ISO 712-V03-707 1989), ash **(**NF V 03-760 1981), crude protein (NF V 03-050/1970) and fat content were carried out according to NF V 03-713 (ISO 7302, 1984)**.** Measurements were carried out in triplicate.

2.3.3. Microbiological properties

Microbiological testing was conducted to research the total flora (NF. 758 1990), *Clostridium* [18] and coliforms (NF. 08053, 1993).

2.3.4. Sensory evaluation

Sensory evaluation was carried out according to the international standard (ISO / DIS11136). A hedonic scale (0 = disliked, 5 = neither liked nor disliked, 10 = liked) was used in accordance with [19]. The pasta samples (50 g/person) were tested on a population of 25 consumers, including 15 women and 10 men, aged from 18 to 60 years. The tested characteristics are color, odor, taste and appearance.

To study the influence of the incorporation of wheat bran on the quality of pasta, averaging used to trace the curves relating to the preferences of subjects for each sensory character selected.

2.4. Statistical analysis

All experiments were carried out in triplicate. Results are expressed as (mean ± standard deviation) and analyzed by one way analysis of variance (ANOVA) and Duncan multiple comparisons test for significance at $P<0.05$, using STATISTICA version 6.1 software.

3. Results and discussion

3.1. Cooking quality parameters

The cooking time of the pasta varied among the different variations [20]. Quality indices such as optimal cooking time (OCT), swelling index (SI) and disintegration coefficient (DC) were used as quality

parameters of pasta. Cooking quality parameters of pasta samples are reported in table 1. Pasta W20 and W25 showed less cooking time of 9 min compared to control sample of 11 min whereas, pasta W10 and W15 took 10 min to cook.

Table 1
Cooking quality parameters

Samples	Cs	W10	W15	W20	W25
OCT (min)	11	10	10	9	9
SI (g water/g dry pasta)	1.75 ± 0.01a	1.93 ± 0.01b	1.97 ± 0.01c	2.01 ± 0.01d	2.04 ± 0.01e
Disintegration Coefficient (DC)	3.12 ± 0.02a	5.01 ± 0.01b	5.42 ± 0.03c	6.12 ± 0.02d	6.10 ± 0.07d
Cooking water aspect	clear	Clear	Clear	Slightly turbid	slightly turbid
Holding of cooking pasta	firm	Firm	Firm	firm	firm

Cs: control sample; W10, W15, W20 and W25: pasta prepared with 10, 15, 20 and 25 g of wheat bran/100 g of semolina respectively. Within the same line, values with a different letter are significantly different (P<0.05).

The literature reported a decrease in OCT pasta at increasing level of semolina substitution with inulin, durum bran and bean flour [10, 21]. On the contrary, Foschia et al. [4] reported a significant increase in OCT for the all combination of fibre-enriched pasta with oat bran, psyllium, glucangel and inulin. However, the OCT for pasta with Barley Balance increased within creasing concentrations of b-glucan. All rates of incorporation of wheat bran in pasta showed a significant increase in SI and DC compared to the control pasta made with exclusively durum wheat semolina (Figure 1). All enriched pasta with wheat bran showed higher SI values than control sample made with semolina. In particular, the highest values were registered for W25 pasta, in agreement with previous studies [4, 16, 22, 23]. The increase in SI can be explained by the higher capacity of wheat bran to absorb and retain water in comparison to the control. The water holding capacity of wheat bran is of the order of 483 g per 100 g of product, approximately five times its weight. The water retention capacity of wheat bran is about 216 g per 100 g of product, approximately 2.2 its weight [4]. Dietary fibers perform many important physiological functions and can play an important role in reducing the potential glycemic index [24].

Many studies suggest that hydration properties of wheat bran mainly depend on its particle size [25]. Conversely, some research works showed a significant decrease in SI at increasing concentrations of inulin or b-glucan in pasta [10, 26]. Table 1 shows a good holding of cooking pasta, but losses begin to appear with 20% incorporation rate due to a higher DC inducing a slightly turbid cooking water aspect.

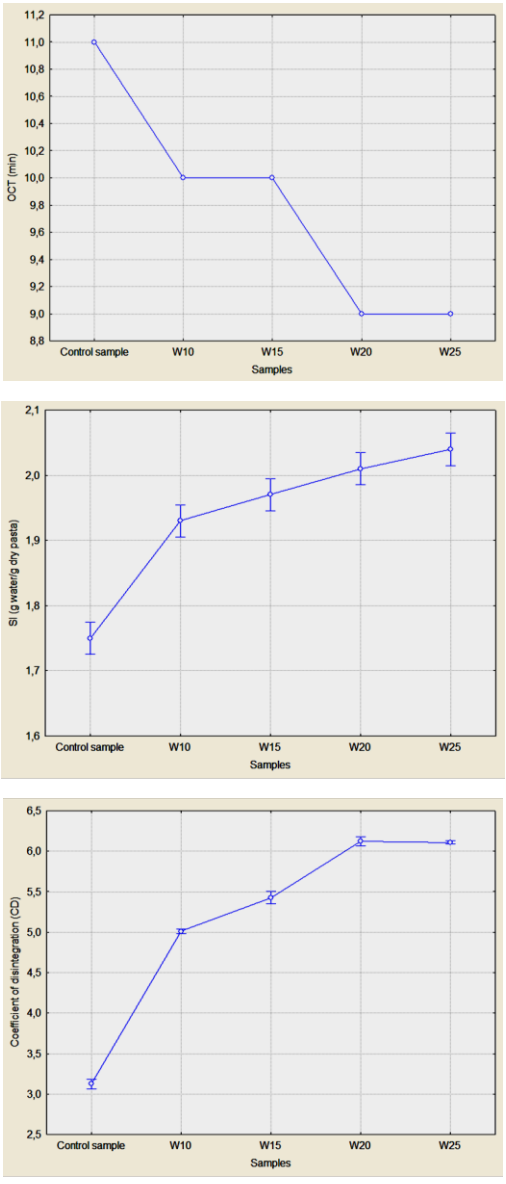

Figure 1: Evolution of cooking quality parameters according to wheat bran rate

3.2. Nutritional properties

The nutritional properties of analyzed pasta samples are summarized in table 2. Moisture content of pasta presented the values of 12.40 ± 0.20, 11.80 ± 0.05, 12.20 ± 0.05, 12.44 ± 0.04 and 12.34 ± 0.04 g/100 g of dry pasta, respectively for Cs, W10, W15, W20 and W25. Ash content showed the values of 0.71 %, 2.2 %, 0.73 % and 7.03 % respectively for Cs, W10, W15, W20 and W25 pasta samples. Pasta W25 had the largest crude protein and fat values, respectively 14.38 ± 0.05 and 0.90 ± 0.01 g/100 g of dry pasta. Pasta W20 followed with rates of 13.93 ± 0.08 and 0.75 ± 0.05 g/100 g of dry pasta, followed by W15 Pasta with rates of 13.82 ± 0.05 and 0.64 ± 0.04 g of dry pasta. Pasta W10 showed rates of 13.23 ± 0.02 and 0.46 ± 0.05 g of dry pasta and the control sample with rates of 13.12 ± 0.01 and 0.45 ± 0.05 g of dry pasta.

This fat content increase could be due to the presence of germ, not separated during milling. The increase in ash content affects the appearance of experimental pasta at 20 % and 25 % of wheat bran incorporation by giving them a dull brown color.

Table 2:
Nutritional properties

Samples	**Cs**	**W10**	**W15**	**W20**	**W25**
Moisture (g/100 g of dry pasta)	12.40 ± 0.20[a]	11.80 ± 0.05[b]	12.20 ± 0.05[c]	12.44 ± 0.04[a]	12.34 ± 0.04[a.c]
Ash (g/100 g of dry pasta)	0.74 ± 0.04[a]	0.92 ± 0.03[b]	0.98 ± 0.04[c]	1.03 ± 0.03[d]	1.14 ± 0.02[e]
Crude protein (g/100 g of dry pasta)	13.12 ± 0.01[a]	13.23 ± 0.02[b]	13.82 ± 0.05[c]	13.93 ± 0.08[d]	14.38 ± 0.05[e]
Fat content (g/100 g of dry pasta)	0.45 ± 0.05[a]	0.46 ± 0.05[a]	0.64 ± 0.04[b]	0.75 ± 0.05[c]	0.90 ± 0.01[d]

Cs: control sample; W10, W15, W20 and W25: pasta prepared with 10, 15, 20 and 25 g of wheat bran/100 g of semolina respectively.
Within the same line, values with a different letter are significantly different (P<0.05).

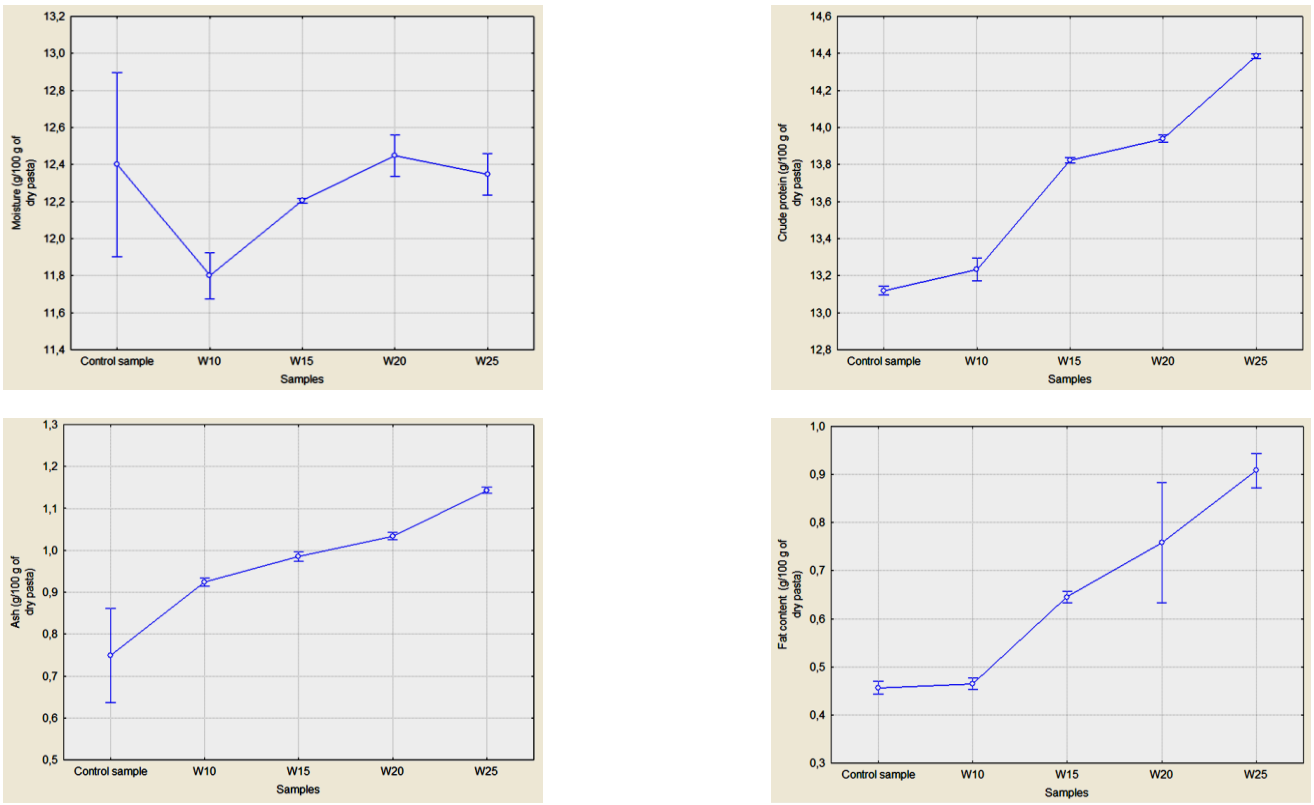

Figure 2: Evolution of nutritional properties according to wheat bran rates

3.3. Microbiological properties

Generally, during routine microbiological analyze of pasta, only yeasts, molds and clostridium sulfito-reductors

are sought. Experimental pasta presented a risk of contamination mainly in wheat bran, hence the importance of their research [27]. The results revealed that the microbiological quality is in conformity with the standards for all pasta.

3.4. Sensory evaluation

Sensory evaluation includes visual examination, smell and taste of the food. Tasting tests can instantly collect a detailed assessment of the influence of the incorporation of wheat bran in pasta at different rates. All results of hybrid hedonic tests meet the requirements of regression models as also indicated by Villanueva and Da Silva [19]. Sensory evaluation of pasta is presented on table 3. Odor is an organoleptic property perceptible by the olfactory organ on sniffing given volatile substances, while the taste is related to the sensations perceived by the taste organ when stimulated by some soluble substances [28]. Color is an element of sensory complex that cannot be underestimated; this is the first characteristic to be perceived. The appearance means the spalling of pasta that are visually assessed (ISO 5492). No significant changes were found in appearance ($p > 0.05$), while color, odor and taste showed significant differences ($p < 0.01$) with the different rates of wheat bran. Pasta W10 and W15 are characterized by the presence of brown needles. However, they still keep a nice yellow color similar to that of control sample pasta. With higher rates of wheat bran (W20 and W25), the appearance of the pasta becomes excessively "dive" and the color becomes much less clear or even brownish. The results of Sensory evaluation are in accordance with the results of earlier studies, where it was also concluded that pasta acceptance decreased with wheat bran incorporation [10, 11, 31]. There is a positive correlation between the preference of the odor and taste with the increase in the incorporation rate of wheat bran. For pasta enriched of wheat bran (W10, W15, W20 and W25), the odor and taste were more pleasant than the control sample (Figure 3).

In this study, the greater the rate of wheat bran incorporation, the lower is the appreciation of color. This surely comes under increasing minerals in pasta due to the incorporation of wheat bran. Minerals are responsible for the brown and dull pasta. However, their dark appearance was little appreciated by the tasting panel, due to the accentuation of browning. W20 and W25 pasta are the cause of bad appearance. Indeed, from a rate of 20 %, the appearance is not really tolerated by the subjects (Figure 3). The best odor and taste are obtained by incorporation rate of 25 %, while the best color and appearance are obtained in the absence of wheat bran in pasta. Pastes enriched of wheat bran have specific organoleptic characteristics that influence their consumer acceptability. Although this product is a safe and effective remedy against certain digestive and metabolic diseases, it remains little appreciated by the consumer. Overall, results obtained in the present study are in agreement with data reported in literature; specifically, pasta enriched with dietary fiber was significantly darker when compared with reference [29, 30, 4]. However, dietary fiber is very interesting in the dietary treatment of hypercholesterolemia in children [32]. They help further to prevent weight gain and improve cardiovascular and gastrointestinal function. Therefore, it becomes important to introduce them in food [33- 35].

Table 3

Sensory evaluation

	Odor [a]	**Taste** [a]	**Color** [a]	**Appearance**
Cs	48.27 ± 4.28	46.74 ± 3.80	66.73 ± 8.67	58.03 ± 10.63
W10	88.21 ± 5.78	55.05 ± 3.61	51.72 ± 7.50	56.72 ± 4.07
W15	56.09 ± 10.73	56.32 ± 3.51	50.00 ± 4.00	55.01 ± 3.76
W20	58.68 ± 3.69	60.68 ± 6.87	36.68 ± 4.39	53.52 ± 3.72
W25	61.85 ± 3.70	65.25 ± 3.78	41.59 ± 4.62	48.45 ± 2.31

[a]*: Significant effect of wheat bran rates ($p < 0.05$).*

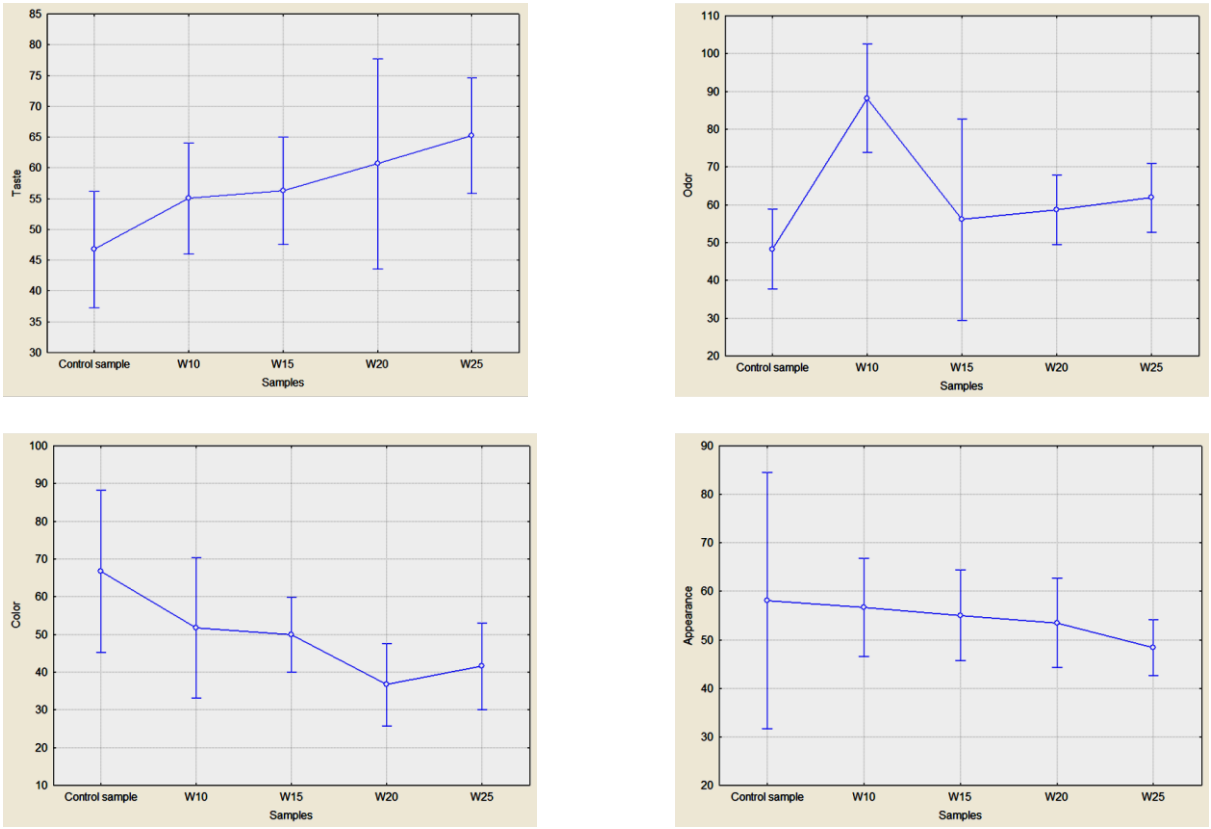

Figure 3: Evolution of Sensory evaluation according to wheat bran rates

4. Conclusion

According to the results, the addition of wheat bran in pasta induced an increase of cooking quality parameters, including optimum cooking time, swelling index and disintegration coefficient. Moreover, pasta enriched with wheat bran had darker color than the control. Otherwise, the nutritional properties of experimental pasta are significantly improved by increasing the wheat bran incorporation rate. Finally, further studies must be performed to better determine the optimal rate of wheat bran to be incorporated into the pasta ensuring maximum consumer acceptability.

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