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Influence of the addition of buckwheat flour and durum wheat bran on spaghetti quality

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Abstract

The quality of nine spaghetti typologies, produced by using wheat durum semolina as a base plus the addition of buckwheat and durum wheat bran, was investigated. The quality of the produced spaghetti was compared with that of spaghetti made only of durum semolina (CTRL). Tests were run on the samples to determine breakage susceptibility and colour of dry spaghetti, the cooking resistance, instrumental stickiness at optimal cooking time (OCT) and overcooking, the cooking loss and sensorial attributes at the optimal cooking time. Results suggest that the breakage susceptibility decreases with the addition of 15% and 20% bran, the spaghetti dry colour changes with the addition of buckwheat flour and bran compared to the spaghetti made only of durum semolina, while the cooking resistance, instrumental stickiness and the cooking loss, in general, were equal to that of the CTRL. However, the addition of buckwheat flour and bran affected the sensorial attributes differently.

Keywords: Buckwheat; Bran; Spaghetti; Breakage susceptibility; Cooking quality

1. Introduction

Pasta is recognized as low in sodium and fat with no cholesterol and a rich source of complex carbohydrates (Giese, 1992). However, it is low in protein and in essential amino acids such as lysine and threonine (Stephenson, 1983). Pasta was among the first food to be authorised by the FDA (Food and Drug Administration) for enrichment with vitamins and iron in 1949 and the WHO (World Health Organization) and the FDA consider pasta a good vehicle for the addition of nutrients.

Several studies have been carried out to improve the nutritional properties of pasta adding to it supplements from various high-protein sources. These supplements can be derived from cottonseed meal, egg albumin, whey proteins as well as bean, yeast protein concentrates and soy isolate (Nielsen et al., 1980). Moreover, high-protein plant materials can also be derived from pea, lupine, buckwheat and can be used as concentrated form, isolates or flour. Soy flour was used to supplement protein in macaroni products and to produce a quick cooking pasta product. Spaghetti with high-protein and high-lysine content can be obtained by adding up to 35% soy flour without adverse effect on flavour and texture and should result in greater acceptability of soy-based food (Shogren et al., 2006). Acceptable cooking quality parameters were obtained in the spaghetti samples containing amaranth, buckwheat and lupine up to 30% of non-conventional flour (Rayas-Duarte et al., 1996). Other authors studied the effect of the addition of dietary fibres, vitamins and minerals on the pasta quality (Bahnassey et al., 1986; Knuckles et al., 1997). Moreover, the effect of the addition of different levels of durum wheat bran to spaghetti was studied (Kordonowy and Youngs, 1985). The by-product of the wheat milling, such as germ, aleuronic layer and bran, can be

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employed in the manufacture of pasta to improve its nutritional content (Buck et al., 1987; Cara et al., 1992; Pagani et al., 1981; Wu et al., 1987).

Buckwheat belongs to the family of *Polygonaceae*, originating in China; it contains starch (65–75%), proteins (10–12.5%), lipids (4.7%), many valuable compounds such as minerals salts (Mg, P, K), vitamins B_1 and B_2 (Steadman et al., 2001), dietary fibre (Bonafaccia et al., 2003) and anti-oxidative substances such as rutin (flavonal glycoside) which is useful to combat vascular disease due to capillary fragility (Watanabe, 1998). Buckwheat proteins are rich in globulin and albumin, but very low in glutelin and prolamin content and they have a high biological value due to well balanced amino acid composition that is rich in lysine and arginine (Pomeranz and Robbins, 1972).

The Pasta quality can be expressed in terms of cooking characteristics, aspect, colour, taste and aroma, which are of great importance for the consumer. During cooking, a weak or discontinuous protein matrix results in a protein network that is too loose and permits a greater amount of exudate to escape during starch granule gelatinization (Resmini and Pagani, 1983). The exudate forms a surface starch and the pasta becomes sticky (Feillet, 1988), giving strands the tendency to clump. During cooking of spaghetti it is possible to define some quality indices such as the optimal cooking time (Feillet, 1984), the weight increase at OCT (pasta yield), the amount of material released into either cooking or washing water, mechanical properties, conventionally defined as firmness, cohesiveness and stickiness (Antognelli, 1980). Also, it is important to evaluate quality index of dry state that represents breakage susceptibility.

The objective of this research is to evaluate the influence of the addition of buckwheat flour and bran, used in several percentages, on the quality of spaghetti in base wheat durum semolina.

2. Materials and methods

2.1. Raw materials

The wheat durum semolina was purchased from a local market. The buckwheat (*Fagopyrum esculentum*) seeds, purchased from a local market, were decorticated and grinded by a Buhler (model-MLU 300 M/s Buhler, Uzwil Switzerland). The bran was obtained by abrasion of the wheat durum kernels (caryopsis) and subsequent winnowing of the debranning dust and contained 18% of protein, 35% of dietary fibre and 7% of ash. Dough was prepared with tap water. The protein and gluten content of mixture flours used to prepare the spaghetti are shown in Table 1.

2.2. Spaghetti preparation

The spaghetti samples were produced from a pilot plant made of an extruder (Sercom, Montpellier, France) and a dryer (Afrem International, Lyon, France). The percentage weight fraction of raw materials used to prepare samples and the spaghetti typologies obtained are reported in Table 1. The dough was 29% of water. The conditions applied were the following: temperature of water 41 °C, kneading time 20 min, drying temperature of 88–89 °C for 1 h and 82 °C for 4 h. The diameter of spaghetti was 1.70 ± 0.03 mm.The nine kinds of spaghetti produced were compared with a CTRL, made only of durum semolina, which was manufactured by the pilot plant mentioned above.

2.3. Spaghetti quality evaluation

2.3.1. Spaghetti colour

Colour of dry spaghetti was determined by Minolta Chroma Meter (Model CR-400, Minolta Co., Osaka, Japan) using the Hunter scale for *L, a, b*. *L* values measure black to white (0–100); *a* values measure redness when positive and greenness when negative; *b* values measure yellowness when positive and blueness when negative. Each data colour represents the mean of five replicates.

2.3.2. Determination of the optimal cooking time and cooking loss

Optimal cooking time was evaluated by observing the time of disappearance of the core of the spaghetti strand during cooking (every 30 s), by squeezing the spaghetti between two transparent glass slides.

Table 1
The percentage weight fraction of raw materials, protein and gluten content of the examined spaghetti typologies*

Spaghetti typologies	Wheat durum semolina (%)	Buckwheat (%)	Bran (%)	Protein content (%)	Gluten content (%)
CTRL	100	–	–	13.5^{a,b}	12.0^{a}
1	80	10	10	13.8^{a}	9.6^{b}
2	75	10	15	14.1^{c}	9.0^{b}
3	70	10	20	14.3^{c}	8.4^{c}
4	70	20	10	13.7^{b}	8.4^{c}
5	65	20	15	14.0^{c}	7.8^{d}
6	60	20	20	14.2^{c}	7.2^{d}
7	60	30	10	13.6^{a}	7.2^{d}
8	55	30	15	13.8^{a}	6.6^{e}
9	50	30	20	14.1^{c}	6.0^{e}

*The mean values in the same column followed by different superscript letters differ significantly ($p < 0.05$).