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Effect of fortification with vegetable purees on sensory and physicochemical properties of wheat flour pasta

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Abstract

The research was conducted in order to evaluate the physicochemical and quality characteristics of vegetable puree-enriched pasta for the improvement of their nutritional value. Samples were made from white wheat flour, and fresh vegetable purees have been added to obtained nutritios pasta: spinach, tomato, and beetroot pasta. The following parameters were analized for the pasta products: acidity, humidity, mineral content, volume variations, water solubility index, water absorption index, dry matter losses on preparation, sensory evaluation and micro structural characteristics. Pasta prepared with vegetable purees showed higher values of moisture content compared to control pasta, being directly proportional to the acidity values. Also, pasta prepared with vegetable purees showed a higher increase in volume after boiling compared to control pasta. The incorporation of vegetable matter has led to a softer texture of pasta, which may be due to the non-starchy nature of vegetables. Pastas with spinach and tomato puree were highly valued for their appearance, color, overall quality, and less for flavour. The incorporation of vegetable purees affects the pasta quality attributes and it imparts natural attractive color to the pasta.

Keywords: pasta, spinach puree, tomato puree, water solubility index, sensory evaluation

1.Introduction

Pastas are one of the oldest, most nutritious and versatile dishes in terms of both gastronomy and nutrition. Pastas are a popular traditional food due to their ease of preparation, low costs, storage stability and nutritional qualities. Their consumption is constantly increasing due to the increasingly diverse demand for food, of new tastes and ever-increasing purchasing power, and people are also more aware of nutrition and health [1, 2].

Pasta is a food product obtained by drying unleavened flour dough made with water, to which salt or eggs can also be added. Colored pasta can also contain vegetables or greens, and they can be cut into different shapes and sizes. The high nutritional value of flour products is based not only on their energy content, conferred by the increased content of carbohydrates and fats, but also by the value of all components, these representing forms that are easily assimilated by the human body.

In addition to some special properties they have, such as the high content of vegetable proteins and integral nutrients of flour, the nutritional unit of pasta is 17 times cheaper than that obtained from meat [3, 4].

Pastas are durable for preservation, can be kept for a long time under normal conditions, at room temperature, without diminishing their nutritional and taste qualities. It also shows rapidity, simplicity and diversity in cooking due to the reduced cooking time. These products provide daily to the human body about 45% of total protein, 65% of total calories and a significant intake of carbohydrates, vitamins, and mineral salts [5, 6].

Thin pastas are used predominantly in soups, long ones in the form of a ribbon are seasoned with sauces and those in tubular form, in the form of salads. Pastas that are wide enough can be filled by the consumers, and those of the ravioli type, are ready filled in the manufacturing process [7].

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During the digestion of pasta, sugars are released gradually, which results in a low post-meal glycaemia and insulin response [8]. A number of studies indicate a variety of factors determining a slow digestion of starch in pasta and a slow liberation of glucose [9, 10].

From an organoleptic point of view, pasta must have a smooth surface, without traces of unframed flour, without visible deformations, resistant to breakage, with a glassy appearance in section, for extra pasta, of uniform white/white-yellow color. After boiling, they must be elastic and do not stick together. Grated flour has a good technological behavior in pasting, because the particles are larger, swell slowly, and preserve the structure of the wheat grain. Small grain flour leads to the production of pasta that at boiling becomes viscous, are degraded, while a larger granulation leads to the white spots on pasta surface with a greater obtaining time. Durum wheat pasta is characterised by low dry matter losses in the course of cooking, high resistance to overcooking, light-yellow colour and good post-cooking texture [4, 5].

Some researchers demonstrated that enriching pasta with dietary fibre, causes a lowering of glycaemic index of the products. Dietary fibre reduces the energy density of the products, shortens the time of passage of the gastric and intestinal content, increases its viscosity and positively affects the metabolism of sugars and lipids [11-13].

Addition of vegetables and fruits to pasta can contribute to a natural attractive look, new tastes, and a sense of a complete meal with all the goodness of the vegetables and fruits that have been incorporated. Conventional vegetable pastas, such as spinach and tomato-containing pastas, consist mainly of wheat flour with about 3 to 3.5 percent by weight or less vegetable solids, and tend to change in color and flavor during processing, storage and upon cooking [14].

The objective of the work consisted in the preparation and appreciation of the quality of simple and vegetable purees-enriched pasta and dough analysis during the drying process. The following pasta parameters were analized: acidity, humidity, mineral content, volume variations, water solubility index (WSI), water absorption index (WAI), dry matter losses on preparation. Effect of addition of vegetable purees on the micro structural characteristics of the prepared pastas was also studied.

2. Materials and Method

2.1 Samples

Samples were made from white wheat flour, and fresh vegetable purees have been added to obtained nutritios pasta: beetroot pasta (R4), tomato pasta (R3) and spinach pasta (R2) respectively, whereas R1 was kept as control (without vegetable puree).

Vegetables such as spinach and beetroot were procured from the local market, washed, sorted, peeled and sliced. Canned tomato puree was procured from the local market for the present work. Each of the other purees were prepared by blanching the slices followed by milling.

The quantity of vegetable purees added was 250 g/kg flour. The dough was kneaded for 10 min, and extruded using a lab scale single screw extruder (Philips, Amsterdam, Netherlands).

The following parameters were analized for the pasta products: acidity, humidity, mineral content, volume variations, water solubility index, water absorption index, dry matter losses on preparation, sensory analysis, and also the micro structural characteristics.

2.2 Physicochemical examination

The chemical composition of the raw materials and pasta products was determined according to the methods described by Sobota et al. and Pop F. [15-17].

Acidity is based on the extraction of the pasta acids and their titration with sodium hydroxide 0.1 N, using phenolphthaleine, as an indicator. The results were expressed as degree of acidity. Determination of moisture content is based on drying of a sample with known initial mass to a constant mass. The content of mineral substances is based on the calcination of a known mass of product up to constant weight.

Weight increase index was calculated by dividing the weight of the pasta after cooking by the weight on uncooked pasta. After cooking each sample, cooking loss was determined by collecting and drying the liquid in which the pasta was cooked. The strainer and saucepan were also rinsed with an extra 100 mL of water, ensuring that any residue lost from the pasta was incorporated into the solution for analysis. This solution was weighed in aluminum pans and dried in a mechanical oven for 24 h at 60 ^{o}C. The difference in weight between the

aluminum pan and the dried aluminum pan with residue is the cooking loss, which is then expressed as a percentage of the dry pasta sample's exact weight before cooking.

Water solubility index (WSI) was determined with the centrifuge method. Two gram of uncooked pasta and 4 g cooked pasta were weighted. The samples were placed in centrifuge tubes, 30 mL of distilled water was added, then the tube were stopped and shook vigorously. The suspension was left to rest for 5 min, then it was centrifuged for 15 min at 2200 g. 10 mL of the supernatant was dried to the solid mass.

Water absorption index (WAI). After downloaded 10 mL of the supernatant to determine the WSI, the remaining supernatant was carefully decanted. The wet samples were weighed, and WAI was calculated [15].

Panels of 15 judges, who are familiar with the quality characteristics of pasta, were recruited to perform the sensory evaluation of cooked pasta using a 4-point hedonic scale. Attributes, which

are indicative of major quality differences in cooked pasta, were selected, i.e. color, flavor, appearance, and overall quality.

Microscopic examination was performed with an Optika-B290 microscope equipped with tablet (Optika, Italy), with the following technical characteristics: binocular, 360° rotating and 30° inclined; interpupillary distance from 48 to 75 mm; built-in 3.1 MP camera; double layer rackless mechanical sliding stage; vernier scale on the two axes, accuracy: 0.1 mm; Abbe N.A. 1.25 condenser, with objective-coded iris diaphragm, focusable and centerable; objectives: N-PLAN 4x/0.10, N-PLAN 10x/0.25, N-PLAN 40x/0.65, N-PLAN 100x/1.25.

All analytical determinations were performed at least in triplicate. Values of different parameters were expressed as the mean ± standard deviation (X ± SD). Significant differences between mean were determined by using "Student" ("t") distribution.

3. Results and Discussion

The acidity of the pastry dough showed an irregular variation during the drying process at 80ºC, presenting an increase in the first 90 minutes for R1 and R2, and in the first 120 minutes for R3 and R4, then a decrease due to enzymes inactivation (Fig. 1).

After preparation, the pastry dough had a moisture content of 26.15% for R1, 31.33% for R2, 33.87% for R3 and 36.42% for R4. In the first 90 minutes of drying, the water evaporation rate is higher, and at 150 minutes there was a slower decrease. At the end of the drying process the pasta passed from the plastic to the elastic state. The elasticity of the pastry dough decreased with the addition of vegetable purees.

After ensuring a pause period, the following physico-chemical parameters were determined (Table 1).

Table 1. Proximate analysis of pasta

Parameters	**R1**	**R2**	**R3**	**R4**
Moisture (%)	$7.11^{a} \pm 0.02$	$8.95^{b} \pm 0.06$	$9.78^{bc} \pm 0.04$	$10.37^{c} \pm 0.05$
Ash (%)	$0.69^{a} \pm 0.05$	$1.14^{ab} \pm 0.01$	$1.56^{b} \pm 0.07$	$1.87^{bc} \pm 0.04$
Fat (%)	$0.51^{a} \pm 0.03$	$0.68^{a} \pm 0.02$	$0.77^{ab} \pm 0.05$	$0.89^{b} \pm 0.06$
Acidity (mL NaOH 0.1N/100g)	$0.57^{a} \pm 0.04$	$0.95^{b} \pm 0.02$	$1.54^{c} \pm 0.05$	$1.82^{cd} \pm 0.03$
Alkalinity (mL HCl 0.1N/100g)	$2.65^{a} \pm 0.02$	$2.11^{a} \pm 0.01$	$1.69^{ab} \pm 0.01$	$1.22^{b} \pm 0.04$
Dought elasticity (%)	$38.25^{a} \pm 0.04$	$25.15^{c} \pm 0.02$	$26.32^{c} \pm 0.06$	$24.58^{cd} \pm 0.05$

Values are means of triplicates ± standard deviation. Values with the same superscript in a line are not significantly different (P > 0.05).

Pasta prepared with vegetable purees showed higher values of moisture content compared to control pasta, being directly proportional to the acidity values. Also, pasta prepared with vegetable purees showed a higher increase in volume after boiling compared to control pasta.

Sobota et al. [15] studied the effect of the addition of common wheat bran on the chemical composition, physical properties, cooking quality and sensory traits of durum wheat pasta. The study reported that pasta containing up to 30% of bran was characterised with lower losses of dry mass and higher resistance to overcooking, in comparison with the pasta made of whole-grain durum. The researchers showed that the addition of wheat bran had significantly negative effect on sensory properties of pasta.

The sensory quality of products containing 35-40% of wheat bran was worse than whole-grain durum pasta.

Chillo et al. [18] found that the addition of high-fibre material to spaghetti caused a significant lowering of brightness and yellow colouring. The pasta with addition of wheat bran and buckwheat was characterised by decidedly darker and more reddish colouring, compared with the pasta from semolina.

The addition of vegetable purees in the pasta caused a decrease of the water solubility index (WSI) value of the products. Brennan et al. [19] argued that products characterized by lower values of the solubility index have a slower digestion.

Water absorption index (WAI) decreased with the addition of vegetable puree to the products, there was determined an inversely proportional relationship between the values of the moisture content and those of the water absorption index. According to Sobota et al. [15] products with higher values of the water absorption index are more effective in satisfying hunger and give a feeling of satiety. For enriched pasta, less loss in preparation was found at cooking.

Rekha et al. [14] studied the incorporaion of various vegetable purees in cooking pastas from non-durum wheat. The results indicated that vegetables cooking pastas had lower cooking loss, swelling index and texture values than the control. Overall sensory scores of all vegetable puree pastas was low as compared to the control except in the case of carrot pasta which had a score comparable with the control.

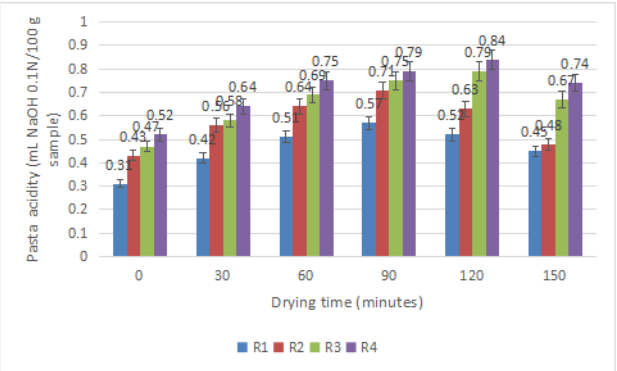

Figure 1. Acidity variation during drying process of pasta

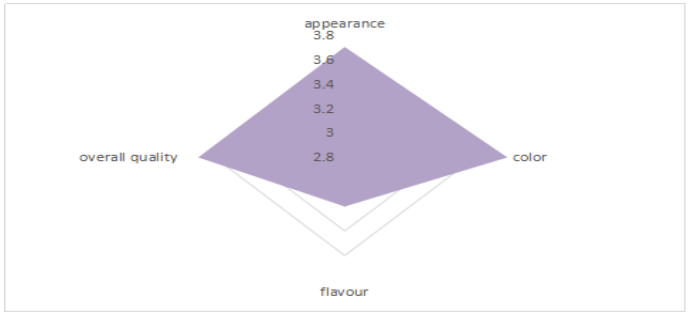

Figure 2. Sensory analysis of control pasta

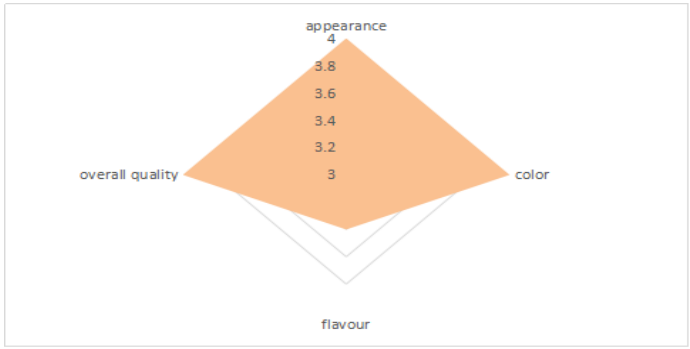

Figure 3. Sensory analysis of spinach puree enriched pasta

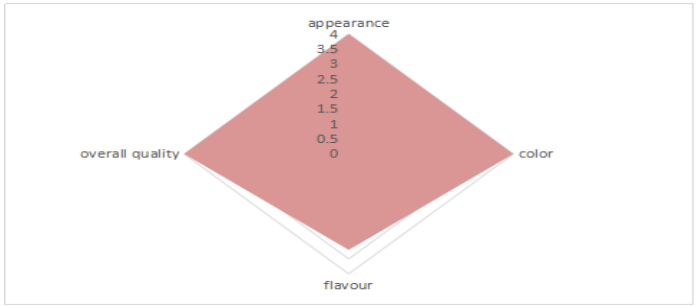

Figure 4. Sensory analysis of tomato puree enriched pasta

Pastas with spinach and tomato puree were highly valued for their appearance, color, overall quality, and less for flavour. The sensory study conducted by Rekha et al., indicated that the incorporation of carrot puree improved the appearance, mouth feel, flavour, and overall quality of the developed pasta [14].

Howard et al. [20] studied the effect of peanut flour incorporation and processing conditions on the pasta's quality and consumer acceptance. The percent peanut flour used to replace wheat flour in durum wheat pasta was found to significantly affect pasta color, cooking loss, and consumer acceptability. Increasing the level of peanut flour in the formula can lead to darker product color, higher cooking loss percentages, and possibly reduced consumer acceptance.

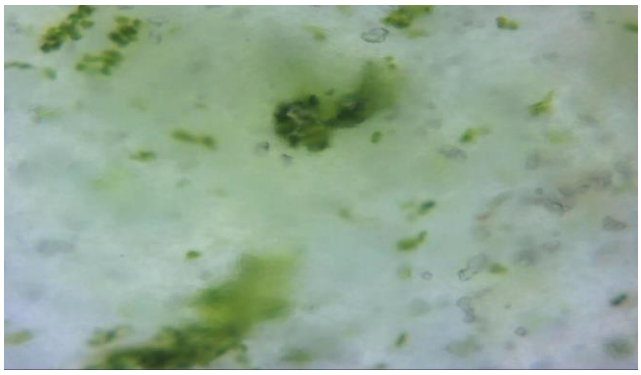

Figure 5. Microstructure of pasta with spinach puree

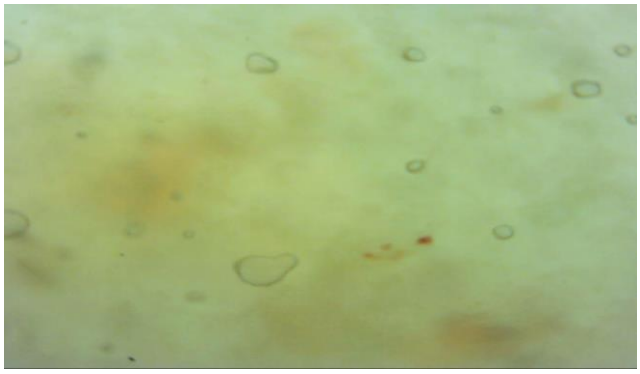

Figure 6. Microstructure of pasta with tomato puree

Conclusion

Vegetable purees, like, spinach, tomato, and beetroot, were incorporated to prepare pasta and their quality attributes were studied. The incorporation of vegetable matter has led to a softer texture of pasta, which may be due to the non-starchy nature of vegetables. A slight reduction in the color intensity of the cooked pasta is due to the swelling of the pasta and the pigments transformation. Pastas with spinach and tomato puree were highly valued for their appearance, color, overall quality, and less for flavour.

According to the microscopic analysis, the protein-starch network was affected by the fibers present in the vegetable purees.

It was observed that the addition of vegetable purees improved cooking quality of all the pastas with less cooking losses. Thus, it may be concluded that the incorporation of vegetable purees affects the pasta quality attributes and imparts natural attractive color to the pasta.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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