
Influence of Raw Materials Rich in Proteins on the Quality of Gluten-Free Noodles

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Abstract: The objective of this work was to develop a premix, fortified in the protein content, allowing the making of gluten-free noodles incorporating raw materials rich in proteins and which permit an adequate physical and sensory property. Soy flour, defatted soy flour, low fat soy flour and whey protein concentrate were used as rich protein ingredients. The following aspects were analyzed: moisture of not cooked noodles, water absorption of cooked noodles, loss of solids by cooking, and some sensorial characteristics as taste, colour and texture. According to the obtained results we have selected low fat soy flour as the flour that provides the best technological response having a minor loss of solids by cooking and a more favourable sensory evaluation.

Keywords: Noodles, Rich Protein Ingredients, Premix For Celiac

1. Introduction

The use of vegetable proteins has been applied for a long time and has spread worldwide. These proteins are mainly from soybean because their nutritional characteristics make it to be a good addition to cereal-based diets. They may be used as flours, concentrates, isolated and textured; remain fit to meet only if they have been processed correctly for human requirements. The great advantage caused by products made from the use of composite flours is that they are made from cereals deficient in the amino acid lysine and using a raw material rich in lysine increases the biological value of such proteins [1]. The most common ingredients used to prepare gluten-free products are corn starch, potato starch, tapioca starch and rice flour. Some researchers have also conducted studies on the development of nutritionally enriched and sensorially acceptable noodles jointly using the defatted corn germ meal, soybean meal and cassava starch to replace the wheat semolina durum [2]. The use of a protein in combination with a polysaccharide is well known by the researchers, but the new concept is to alter the protein structure at nanoscale [3]. The elaboration of gluten-free noodles using sweet potato flour fortified with soy flour and soy protein isolate in different proportions, allowed to obtain variations in both the strength and cohesiveness, but very

acceptable products were obtained in all cases [4]. The fact that Argentina is one of the largest producers of soybeans in the world and considering that the waste from oil soybean industry are of high volume, support the conclusion that there are alternatives to use this raw material in the production of other improved foods from the point of view of the protein quantity and quality [5]. Whereas foods of social interest are intended to have high nutritional value products that can be used in the preparation of traditional dishes without having to create new eating habits, these products based in soy bean can satisfy this requirement [1]. On the other hand, researchers have intensified investigations concerning the use of whey protein concentrate (WPC) in noodles such as macaroni type. The enriched product has a high nutritional value because of the presence of lysine, methionine and tryptophan in the WPC used as raw material. Also is considered a good supplement because it suffers minimal changes during noodle making, including the cooking stage [6, 7]. This whey protein concentrate (WPC) is a by-product of the cheese making process in which the insoluble proteins that form the principal product are separated of the soluble whey proteins. This whey and through techniques such as ultrafiltration becomes protein concentrate, which is used by different food industries [8]. The functional properties of different raw materials rich in proteins are innumerable. They are its emulsifying capacity, the possible replacement of fat

in diet products, its high solubility, its aeration power, its potential in the development of colour and flavour, its binding action with water, among others [9].

The aim of this work was to develop a premix, fortified in the protein content, allowing the making of gluten-free noodles incorporating raw materials rich in proteins and which permit an adequate physical and sensory property.

2. Material and Methods

2.1. Materials

ALDEMAN cassava starch [13.5% moisture, 0.10% protein (% N x 6.25), 55-63 °C gelatinization temperature] was from Cooperativa Agrícola Industrial San Alberto Ltda., Misiones, Argentina. TRIMACER rice flour [13.5% moisture, 6.2% protein (% N x 6.25), 65-72 °C gelatinization temperature] was a product of Atilio Betella y Cía, Santa Fe, Argentina. Pregelatinized cornstarch GLUTAGEL "NT", [8% moisture; 0.2% protein (N x 5.7); Brookfield viscosity cold-gel at a concentration of 8% and 100 rpm: 800-1600 cp] was from Glutal SA, Esperanza, Argentina. Guar gum (1% viscosity 3000 cp) was from Chemistry Oeste, Buenos Aires, Argentina. Egg powder (3% moisture; 43% protein) provided by Poultry Company Inc., Santa Fe, Argentina. Soy Flour (SF) [14.0% moisture, 23.1% protein (% N x 6.25), 18% fat]; Defatted Soy Flour (DSF) [7.5% moisture, 40.5% protein (% N x 6.25), 3.0% fat]; and Low Fat Soy Flour (LFSF) [7.2% moisture, 44% protein (% N x 6.25), 8% fat] from América Pampa Agroindustrial S. A., Buenos Aires, Argentina. Whey Proteins Concentrate (WPC) [3.2% moisture, 35% protein (% N x 6.38), 3.5% fat, 51.3% lactose] provided by Milkaut S.A., Santa Fe, Argentina. The four raw materials rich in proteins (SF, DSF, LFSF and WPC) were tested at levels of 0, 5, 10 and 15%.

Equipment used included an Oster mixer with two stainless steel whisks at 400 rpm. The apparatus used to laminate and cut the dough was Top House Model QF 150.

2.2. Noodle Manufacture

Noodles were manufactured according to the formulation selected by Sabbatini *et al.* [10] and shown in Table 1. Raw materials rich in proteins were used as variables.

Table 1. Formulation for gluten free noodle using raw materials rich in proteins

Raw material	Quantity (g)	Proportion
Cassava starch	97.5	100 (65-20-15)
Rice flour	30.5	
Pregelatinized comstarch	22.5	
WPC	variable	variable
Soy Flour (SF)	variable	variable
Defatted Soy Flour (DSF)	variable	variable
Low Fat Soy Flour (LFSF)	variable	variable
Egg powder	22.5	15
Guar gum	3.0	2
Salt	3.0	2
Water	78	52

Powder ingredients (corn starch, rice flour, cassava starch, raw material rich in protein, guar gum, egg powder and salt, were mixed at 400 rpm for 1 min. Water was added and then two minutes of mixing until achieve the formation of pellets. Then the dough was laminated gradually decreasing the spacing of the rollers, from the position 1 (4 mm) to the position 7 (1.5 mm). Once the dough was sheeted to a thickness of 1.5 mm was cut into wide strips using the same Top House laminator with the appropriate fixture for cutting and so obtains the noodles.

2.3. Noodle Evaluation

2.3.1. Moisture of Not Cooked Noodles

It is determined at 105°C for 24 hours, weighing 3-5 grams of sample. The determinations were performed in triplicate and the moisture values emerged using the following equation:

$$\text{Moisture (\%)} = \frac{(\text{weight of wet noodle} - \text{weight of dry noodle})}{\text{weight of wet noodle}} \times 100.$$

2.3.2. Water Absorption of Cooked Noodles

Water absorption emerged using the method by measuring the moisture on samples of noodles cooked during five minutes. It was determined at 105°C for 24 hours on 3-5 grams of sample. Water absorption values were obtained by triplicate and using the following equation:

$$\text{Water absorption} = \frac{\text{moisture of cooked sample}}{(100 - \text{moisture of cooked sample})}$$

2.3.3. Loss of Solids by Cooking

For each test 15 g of noodles, of approximately 10 cm long, were introduced into a container with 150 ml boiling water. After the time selected, the sample was drained and washed three times with 10 ml of water at 20°C. This washing water was added to the water cooking. An aliquot of 25 ml was taken from the total volume of water in which the amount of solids was determined by evaporation at 105°C during 24 hours. The amount of solids was referred to the original sample according to the following equation:

$$\text{Loss by cooking (\%)} = \frac{(\text{weight of total solids in the cooking water and washing} / \text{dry weight of noodles before cooking}) \times 100}{100}$$

2.3.4. Sensory Analysis

Noodles obtained in experimental tests were subjected to scoring to determine their sensory characteristics on a comparative basis. Experts in a number of four scored the individual characteristics of the noodles which were related to those of a hypothetical standard noodle. Each sample was served at the same time after they were cooked. Experts scored each sample once and assigned scores on a scale of 1-10 for texture (firmness, chewiness and stickiness), colour and taste. The scale of values established was: Excellent (9-10), Very Good (8-9), Good (7-8), Regular (6-7), Fair (5-6), Very Poor (4-5) and Unacceptable (1-4).

2.4. Statistical Analysis

Analysis of variance (ANOVA) was performed and the mean values of triplicates were compared to establish significant differences according to the method of Duncan's Multiple Range [11].

3. Results and Discussion

3.1. Moisture of Not Cooked Noodles

Table 2 shows the results of moisture values obtained with the gluten free noodles, made with raw materials rich in proteins, showing that increasing the level of WPC, produces a decrease in the moisture content. This happens as a consequence that an increasing of the amount of WPC in the formulation makes necessary to decrease progressively adding water to make smooth dough. This addition of water, if excessive, produces greater plasticity and a loss of technological quality [12].

Table 2. Moisture of gluten free noodles made with raw materials rich in proteins

Level (%)	Moisture (%)			
	WPC	SF	DSF	LFSF
0	37.4ab	37.4ab	37.4ab	37.4ab
5	35.5d	37.1bc	37.4ab	37.6a
10	33.9e	36.9bc	37.6a	37.8a
15	33.5e	36.7c	37.1bc	37.9a

WPC: Whey protein concentrate. SF: Soy flour. DSF: Defatted soy flour. LFSF: Low fat soy flour Different letters indicate significant differences ($p < 0.05$)

Moreover, when the added soy flour is analyzed, it is observed that the moisture content is almost constant when increases the replacement percentage. This occurs despite the fact that with increasing the soy flour content in the formulation we should incorporate an increasing amount of water to achieve good quality noodle, which is different from what happens with the WPC. This agrees with Perez et al. [13], which with the addition of soy protein derivatives in sugar cookie dough does not get final increased dough moisture.

Since the WPC gives plasticity to the dough and the soy flour tends to make it dry and tough, it would be expected that the simultaneous addition of these two ingredients results in a dough with acceptable characteristics. Obviously the proteins of WPC and soy flours do not interact in the same

way to do the dough [8, 14]. Whey proteins have a globular conformation in which the polypeptide chains have a uniform distribution of hydrophobic groups and polar groups at pH close to seven, which make them spherical shape and fold the inward to the hydrophobic group and outward to the polar group with generating a relatively labile structure that gives high plasticity to the dough [15].

3.2. Water Absorption of Cooked Noodles

Table 3 shows the values of water absorption obtained when WPC and three different soybean flours are used as protein-rich ingredients.

Table 3. Water absorption of gluten free noodles made with raw materials rich in proteins

Level (%)	Water absorption (g of water/g of dry sample)			
	WPC	SF	DSF	LFSF
0	2.03 d	2.03d	2.03d	2.03d
5	1.87 f	2.08d	2.10cd	2.05d
10	1.94 e	2.14cd	2.22b	2.13c
15	2.13 c	2.16c	2.37a	2.25b

WPC: Whey protein concentrate. SF: Soy flour. DSF: Defatted soy flour. LFSF: Low fat soy flour Different letters indicate significant differences ($p < 0.05$)

Analyzing Table 3 we can see that although at low levels of WPC replacement there is a reducing water absorption compared to the control, when increases this replacement level with WPC also increases the amount of water retained. On the other hand, soy flours have water retention higher than control at low replacement values, thus being always higher than control at higher levels of use. This may be because the soy proteins compete strongly for water with the other proteins present in the formulation, which coincides with some stipulations [16], who pointed out that soy proteins have a high hydrophilicity, competing for the water not only with the proteins present in the formulation, but also with starch.

3.3. Loss of Solids by Cooking

In Table 4 it can be seen that for all analyzed raw materials there is an increase in the loss of solids by cooking when increases the percentage replacement, either at zero time as cooking time of 5 minutes, this latter one is for when the noodles are cooked "al dente".

Table 4. Loss of solids, at 0 and 5 minutes cooking, of gluten free noodles made with raw materials rich in proteins

Level (%)	Loss of solids by cooking (%)							
	WPC		SF		DSF		LFSF	
	0 min	5 min	0 min	5 min	0 min	5 min	0 min	5 min
0	0.86f	6.10h	0.86f	6.10h	0.86f	6.10h	0.86f	6.10h
5	1.26cd	7.70e	1.39c	8.31d	1.23d	7.06fg	1.08e	5.06j
10	1.57b	8.48d	1.64b	9.18b	1.22d	8.09d	1.27d	5.52i
15	1.97a	8.66c	1.61b	10.10a	1.52b	8.89bc	1.11e	6.72g

WPC: Whey protein concentrate. SF: Soy flour. DSF: Defatted soy flour. LFSF: Low fat soy flour Different letters indicate significant differences for 0 and 5 minutes separately ($p < 0.05$)

The cooking time is especially important because it affects the texture and flavour of pasta. So if pasta is cooked less than indicated, the texture will be hard and a flour flavour highlighted; if instead noodles are overcooked, they become whitish, easily broken into small pieces and have soft and sticky texture, which is regarded by consumers as an unpleasant mouth feel [17].

Comparing the behaviour of SF, DSF and LFSF, is more convenient to use the latter because for the same percentage added to the formulation, the cooking loss is much lower.

3.4. Sensory Analysis

Table 5 shows the results of sensory evaluation of noodles made with WPC and the different types of soy flour, at a substitution level of 15%.

Table 5. Sensory analysis of gluten free noodles made with 15 % of raw materials rich in proteins

Score				
Attributes	WPC	SF	DSF	LFSF
Taste	4.8c	5.1bc	5.9b	8.0a
Colour	7.0b	6.2c	7.5b	9.3a
Texture	6.8c	7.8b	8.0b	9.7a

WPC: Whey protein concentrate. SF: Soy flour. DSF: Defatted soy flour. LFSF: Low fat soy flour Different letters indicate, for each attribute, significant differences ($p < 0.05$)

In noodles added with the low fat soy flour (LFSF) we found a better assessment on the attributes of flavour, colour and texture compared with the WPC and with the other soy flours used.

4. Conclusions

Based on the results obtained from this study, we have selected the low fat soy flour (LFSF) as the flour that provides the best technological responses having a minor loss of solids by cooking and a more favourable sensory evaluation. We have determined a better assessment in all sensory attributes.

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