Effect of adding unconventional raw materials on the technological properties of rice fresh pasta

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Abstract

The aim of this study was to develop *fettuccini* type rice fresh pasta by cold extrusion. To produce the pasta, a 2^2 Central Composite Rotational Design was used, in which the effects of the addition of pre-gelatinized rice flour – PGRF (0-60%) and modified egg albumin – MEA (0-10%) were studied. The dependent variables were the results of the cooking test and of the instrumental texture. The optimum cooking time for all of the formulations of rice fresh pasta was 3 minutes. MEA had a greater effect on increasing the weight of the pasta when compared to that of PGRF. It was found that with the addition of PGRF increase in loss of solids in cooking water, whereas MEA exerted the opposite effect on this parameter. Moreover, the maximum value of MEA (10%) had an optimum effect on pasta firmness, while PGRF had a negative effect on this parameter. The maximum values of PGRF and MEA reduced the stickiness of the pasta. Based on these results and on the parameters considered as most important, the rice pasta with the best technological characteristics was that with the maximum levels of MEA (10%) and no addition of PGRF (0%). This product was submitted to sensory and microbiological analyses, with good results.

Keywords: gluten; pre-gelatinized rice flour; modified egg albumin.

1 Introduction

Pasta is a food product produced mainly by mixing durum wheat semolina and water. It can be consumed after processing as fresh pasta or it can also be dried for future use. Common pasta produced with wheat has better quality parameters (low loss of solids in cooking water, firm pasta structure, reduced stickiness, etc.) than those of rice pasta. During pasta processing, gluten is mainly responsible for the formation of the structure. Gluten is considered to be the most significant factor related to pasta cooking quality. Gluten consists of gliadin and glutenin and is responsible for elasticity and "al dente" chewability of pasta, which is highly appreciated by consumers (SOZER, 2009).

However, some people with a specific genetic nature suffer from celiac disease which is usually manifested as a digestive malfunction of intestines, caused by the presence of gluten. Thus, the only treatment is a lifelong adherence to a gluten-free diet. This diet excludes the intake of storage proteins found in wheat, rye, barley, and oats (YALCIN; BASMAN, 2008; SCHOENLECHNER et al., 2010; JUSZCZAK et al., 2012).

According to the National Federation of Brazilian Celiac Associations (FEDERAÇÃO…, 2012), it is estimated that over a million Brazilians have celiac disease. This information indicates the need for new gluten-free products in the Brazilian market, such as pasta.

Rice is recommended as a safe food for celiac patients since it possesses no gluten and can be used in the production of pasta. However, during production of pasta from rice, some technological problems can arise due to the lack of gluten. When rice flour is used as the only ingredient for pasta production, it requires additives or particular processing techniques to modify in a suitable way the properties of macromolecular components (starch and proteins), relevant to the structure of the final product (CABRERA-CHÁVEZ et al., 2012).

Pre-gelatinized rice flour favors polymerization with the untreated starch fraction creating a structure that performs functions similar to gluten, thus avoiding stickiness of the pasta after cooking. However, it is expected that the cooking time of rice fresh pasta is reduced when compared to that of wheat pasta (PAGANI, 1986; RAINA et al., 2005; CABRERA-CHÁVEZ et al., 2012).

Egg proteins contribute to the formation of a more compact pasta protein network yielding a harder and tougher product, both before and after cooking. In addition, egg albumin reduces the quantity of solids in cooking water and, consequently, the stickiness of pasta, while increasing its nutritional value (ORMENESE et al., 2004; ALAMPRESE; CASIRAGHI; ROSSI, 2009, 2011).

Thus, the aim of this study was to develop *fettuccini* type rice fresh pasta via by cold extrusion and evaluate the influence of the addition of pre-gelatinized rice flour and modified egg albumin on the cooking characteristics and texture of the pasta. The optimized product was also submitted to sensory and microbiological analyses.

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2 Materials and methods

2.1 Raw materials

In this study, the rice flour (RF) and the pre-gelatinized rice flour (PGRF) were kindly donated by Josapar (Pelotas/RS, Brazil), and the acidified desugared modified egg albumin (MEA) (a product with a high gel strength), was kindly donated by AB Brasil (Jundiaí/SP, Brazil).

2.2 Proximate composition and particle size of raw materials

The different rice flours and the egg albumin were characterized according to their proximate composition by the analysis in triplicate for moisture, protein, ash, and lipids using, respectively, AACC Methods 44-15.02, 46-13.01, 08-01.01 and 30-25.01 (AMERICAN…, 2011). Carbohydrates were calculated by difference. The particle size was determined by adding 100 g of sample to a Granutest Tyler sieves (model 295) equipped with six sieves (openings of 0.84 mm (US n. 20), 0.42 mm (US n. 35), 0.25 mm (US n. 60), 0.177 mm (US n. 80), and 0.149 mm (US n. 100)) for 30 minutes. The fractions of the flours retained in the sieves were weighed, and the results were expressed in percentage.

2.3 Water absorption index and optimal water amount for each formulation

The amount of water added to each formulation was established according to the Water Absorption Index (WAI) and determined in triplicate for raw materials and for the 12 trials that composed the design, following the methodology proposed by Anderson et al. (1969). Based on the results obtained for WAI, it was possible to obtain the optimal amount of water to be added in each formulation, according to Equation 1.

$$\text{Amount of water (\%)} = a * b/c \tag{1}$$

where: a = WAI of each formulation; b = optimal amount of water added to the base formulation (100% rice flour and 41% water); and c = WAI of rice flour (g centrifugation residue/unsolubilized dry matter).

2.4 Processing of fresh pasta

The fresh pasta was processed using the extrusion device Pastaia II with a screw with 1:1 compression ratio and *fettuccini* die (dimensions: 5.2 × 1.7 mm) coated with Teflon. For each trial, 500 g of rice flour and the amounts of pre-gelatinized rice flour and modified egg albumin defined in the experimental design (item 2.5) were used. First, a pre-mix of all dry raw-materials was prepared using a Kitchen Aid mixer at slow speed for 2 minutes. Then, water was added using a graduated measuring cylinder by continuously mixing at slow speed until complete water incorporation (approximately 1 more minute). This mix was placed in the Pastaia II equipment. The extruded fresh pasta was cut into lengths of 25 cm, vacuum packed (700 mmHg) in bi-oriented polypropylene plastic bags, and stored in a refrigerator at 4 °C to evaluate the shelf life.

2.5 Experimental design

The optimization of the formulation of the fresh pasta was performed using a 2^2 Central Composite Rotational Design (CCRD) in order to study the effects of adding PGRF (0-60%) and MEA (0-10%) on the production of fresh rice pasta by the cold extrusion process. For each 100 g of rice flour, different percentages of pre-gelatinized rice flour (PGRF) and modified egg albumin (MEA) were added, according to the experimental design (Table 1). The amount of water added to each formulation was determined according to item 2.3. The maximum levels were chosen in preliminary tests by adding the maximum possible amount of PGRF and MEA to obtain a dough that exhibits proper extensibility and elasticity for the production of fresh pasta.

2.6 Cooking test

The cooking test was performed in triplicate using AACC Method 16-50 (AMERICAN…, 2011). In order to evaluate the cooking time, the pasta was added to boiling water and a sample was removed at 1-minute intervals. The pasta samples were pressed between two glass plates, and the optimum cooking time was defined as the time when the opaque center strip (of non-gelatinized starch) disappeared. The cooked pasta weight increase was determined by comparing 10 g of the sample before and after cooking, using the optimum cooking time. The loss of solids in cooking water was determined by evaporation of 25 mL of the cooking water plus residue in an oven at 105 °C until constant weight.

2.7 Texture of cooked pasta

The parameters firmness and stickiness were analyzed using a TA-XT2i texture analyzer (Stable Micro Systems, Haslemere, Surrey, England) with probes A/LKB and HDP/PFS, respectively. The results of each parameter were obtained from the arithmetic means of seven replicates.

2.8 Statistical analysis

The data obtained in the experimental trials were evaluated using the Response Surface Methodology with the statistical program Statistica 5.0 (Statsoft, Tulsa, OK, EUA) to calculate the effects, the coefficient of determination, and the analysis of variance (ANOVA) with a significance level of 10%. The minimum coefficient of determination (R^2) of the ANOVA was 0.70 to ensure the validity of the predictions made by the mathematical model and to generate the response surfaces.

Table 1. Values used in Central Composite Rotational Design to produce the rice fresh pasta.

Variables	Levels				
	−1,41	−1	0	+1	+1,41
PGRF	0	9	30	51	60
MEA	0	1,5	5	8,5	10

PGRF: pre-gelatinized rice flour (%); MEA: modified egg albumin (%).

2.9 Definition and characterization of the optimal point

For choosing the optimum point, all responses (cooking test and instrumental texture) were taken into account. It is desirable for pasta products to have low cooking time, low loss of solids in cooking water, and high weight increase of cooked product; high firmness and low stickiness are also desired.

The optimum point was analyzed for weight increase, loss of solids, firmness, and stickiness to validate the experimental design. The optimum pasta was also characterized according to its proximate composition by the analysis in triplicate of moisture, protein, ash, lipids, and carbohydrates using the previously mentioned methods.

The shelf life of the fresh pasta was evaluated on the day of processing and after 4, 7, and 14 days of storage. The following microbiological analyses were performed: thermo-tolerant coliforms, using the technique of Most Probable Number (MPN) of three tubes and *Escherichia coli* - EC broth (Merck), to confirm the presence of coliforms at 45 °C, analysis of aerobic mesophilic and psychrotrophic microorganisms, using the Plate Count Agar – PCA (Oxoid) and yeasts and molds, using Potato Dextrose Agar – PDA acidified with 10% of tartaric acid, according to the American Public Health Association (AMERICAN…, 1992).

Sensory acceptability of the fresh pasta was determined by 30 untrained panelists after approval by the Research Ethics Committee of UNICAMP (Project n. 1271/2010). The sensory attributes evaluated were appearance, aroma, flavor, texture, and overall impression using a 9-point hedonic scale (1 = "dislike extremely" to 9 = "like extremely"). Purchase intention of the fresh pasta was also evaluated using a 5-point scale (1 = "definitely would not buy" to 5 = "definitely would buy").

3 Results and discussion

3.1 Percent composition and particle size of raw materials

The proximate compositional data summarized in Table 2 indicate that the samples of rice flour, pre-gelatinized rice flour, and modified egg albumin had significant differences ($p < 0.05$) in moisture, protein, and lipid contents. For ash content, the rice flours did not exhibit significant differences ($p > 0.05$), but they differed significantly from the modified egg albumin.

Modified egg albumin, as expected, had high protein content, 85.96%. The rice flours had high carbohydrate content, 83.99% and 85.12% for RF and PGRF, respectively, due to their abundance in starch. The levels of moisture, protein, ash, lipids, and carbohydrates are important for a better characterization of the flours. Similar levels have been found in the literature (SILVA; ASCHERI; PEREIRA, 2007; UNIVERSIDADE…, 2011).

It is observed that the moisture content of all raw materials was low, ensuring their conservation. The Brazilian legislation establishes a maximum of 15% (g/100g) for flours (BRASIL, 2005).

In Table 3, it can be observed that 44.9% of the rice flour particles and 66.77% of the pre-gelatinized rice flour particles corresponded to fine particles and were retained in the sieve with opening < 0.149 mm (US n. > 100), and 30.3% and 24.6% of the rice flour and pre-gelatinized rice flour, respectively, were found in the US n. 80 with sieve openings of 0.177 mm. According to Hemavathy and Baht (1994), pastas made of rice flour with very fine particles are sticky and have little firmness. However, Nura et al. (2011) argued that smaller rice flour particles improve the texture characteristics of the pasta since more amylose is released into the starch gel which could result in its rapid retrogradation and consequently an increase in gel firmness.

3.2 Water absorption index

The different raw materials and mixtures of RF, PGRF, and MEA had water absorption index values between 2.39% and 3.27% for the 11 trials (Table 4). The analysis of variance showed a coefficient of determination (R^2) equal to 0.97 and a value of calculated F 67.9 times greater than the tabled F, with 5% of level of significance. These results validated the mathematical model $y = 2.85 + 0.29 * PGRF$ and allowed the construction

Table 2. Proximate composition of raw materials used to produce the fresh pasta.

Raw materials	Moisture (%)	Protein (%)	Ash (%)	Lipids (%)	Carbohydrates* (%)
RF	6.53 ± 0.02^{b}	8.71 ± 0.16^{b}	0.39 ± 0.03^{b}	0.38 ± 0.04^{b}	83.99
PGRF	5.29 ± 0.13^{c}	8.44 ± 0.23^{c}	0.45 ± 0.01^{b}	0.70 ± 0.12^{a}	85.12
MEA	7.46 ± 0.08^{a}	85.96 ± 0.21^{a}	4.78 ± 0.03^{a}	0.12 ± 0.02^{c}	1.68

Arithmetic means of three replicates ± standard deviation. Columns denoted by different lowercase letters in the same are significantly different ($p < 0.05$). RF: rice flour; PGRF: pre-gelatinized rice flour; MEA: modified egg albumin; *Calculated by difference.

Table 3. Particle size of raw materials used to manufacture fresh pasta.

Sieve (US n.)	Opening (mm)	RF (%)	PGRF (%)
>100	<0.149	44.9 ± 1.6	66.7 ± 2.8
100	0.149	7.9 ± 2.2	5.9 ± 0.9
80	0.177	30.3 ± 0.3	24.6 ± 2.3
60	0.25	16.0 ± 0.1	1.6 ± 0.1
35	0.42	0.5 ± 0.1	0.3 ± 0.0
20	0.84	0.5 ± 0.1	1.0 ± 0.1

RF: rice flour; PGRF: pre-gelatinized rice flour.

Table 4. Water Absorption Index (WAI) and the amount of water added to each formulation of pasta.

Raw materials and trials	PGRF (%)	MEA (%)	WAI (g centrifugation residue/unsolubilized dry matter)[a]	Water added (%)
RF	-	-	2.70	41
PGRF	-	-	5.92	-
MEA	-	-	5.60	-
1	−1	−1	2.64	40
2	+1	−1	3.17	48
3	−1	+1	2.62	40
4	+1	+1	3.14	48
5	−1.41	0	2.39	36
6	+1.41	0	3.27	49
7	0	−1.41	2.86	43
8	0	+1.41	2.80	42
9	0	0	2.86	43
10	0	0	2.86	43
11	0	0	2.83	43

[a]Arithmetic means of three replicates. RF: rice flour; PGRF: pre-gelatinized rice flour; MEA: modified egg albumin.

of the response surface (Figure 1a). It can be seen that the amount of water to be added in the processing of pasta varies with the amount of PGRF. PGRF favored water absorption since gelatinization leaves a greater amount of free hydroxyl groups available to form hydrogen bonds with water (CLERICI; EL-DASH, 2008). On the other hand, MEA did not influence WAI. It is possible that PGRF, being pre-gelatinized, absorbed water rapidly, without leaving much water available for MEA. Table 4 shows the amount of water added to each formulation

3.3 Cooking test

The optimum cooking time for all of the formulations was 3 minutes; therefore, the rice fresh pasta can be considered a rapid preparation product. This result shows that the pre-gelatinized rice flour and the modified egg albumin did not affect the cooking time. The good result obtained can also be related to the high initial moisture, which is characteristic of fresh pasta.

The different formulations exhibited weight increase between 1.57% and 1.91% for the 12 trials (Table 5), with a coefficient of variation (CV) below 3.99%. Using a level of significance of 10%, the analysis of variance showed a coefficient of determination (R^2) equal to 0.80 and a value of calculated F 3.66 times greater than the tabled F. These results validated the mathematical model $y = 1.69 + 0.03 * PGRF + 0.08 * MEA + 0.06 * PGRF * MEA$ and allowed the construction of the response surface (Figure 1b).

It can be seen that PGRF and MEA had an effect on weight increase of pasta. However, the effect caused by MEA was higher than that caused by PGRF.

According to Hummel (1966), good quality dried wheat-based pasta should have a weight increase of 2 times its original weight. In addition, the pasta weight increase is related to the capacity of water absorption and to the shape of the pasta. The values obtained for the fresh pasta are low when compared to those of dried pasta.

In the products derived from rice, a system with a definable structure cannot be formed due to the absence of a binding agent. Therefore, the water absorption rate is very low. In the presence of polymers, such as gums and proteins, the attractive forces increase (CHANAMAI; McCLEMENTS, 2001; SIVARAMAKRISHNAN; SENGE; CHATTOPADHYAY, 2004). Furthermore, the small weight increase observed can be attributed to the high initial moisture, inherent of the fresh pasta (PAUCAR-MENACHO et al., 2008).

The loss of soluble solids in cooking water ranged from 1.83% to 4.75% for the 12 trials (Table 5), with a coefficient of variation (CV) below 11.6%. The analysis of variance showed a coefficient of determination (R^2) equal to 0.72 and a value of calculated F 2.36 times greater than the tabled F, with 10% level of significance. These results validated the mathematical model $y = 4.19 + 0.70 * PGRF - 0.66 * MEA - 0.76 * MEA^2$ and allowed the construction of the response surface (Figure 1c).

Based on the results obtained, it can be seen that the addition of PGRF increased the loss of soluble solids in the cooking water, which is undesirable. On the other hand, MEA exerted an opposite effect on this parameter.

In gluten-free pasta, solid loss during cooking is mostly due to solubilization of loosely bound gelatinized starch from the surface of the product. This phenomenon depends mainly on the degree of starch gelatinization and the strength of the retrograded starch network surrounding the gelatinized starch (MARTI; SEETHARAMAN; PAGANI, 2010).

Furthermore, egg albumin contributes to the formation of a protein network and improves the retention of the starch by the network, which avoids the leaching of starch in the cooking water (MILATOVIC; MONDELLI, 1990).

All the formulations of rice pasta presented loss of soluble solids lower than 6% and can be characterized as pasta of good quality (ORMENESE; CHANG, 2003).

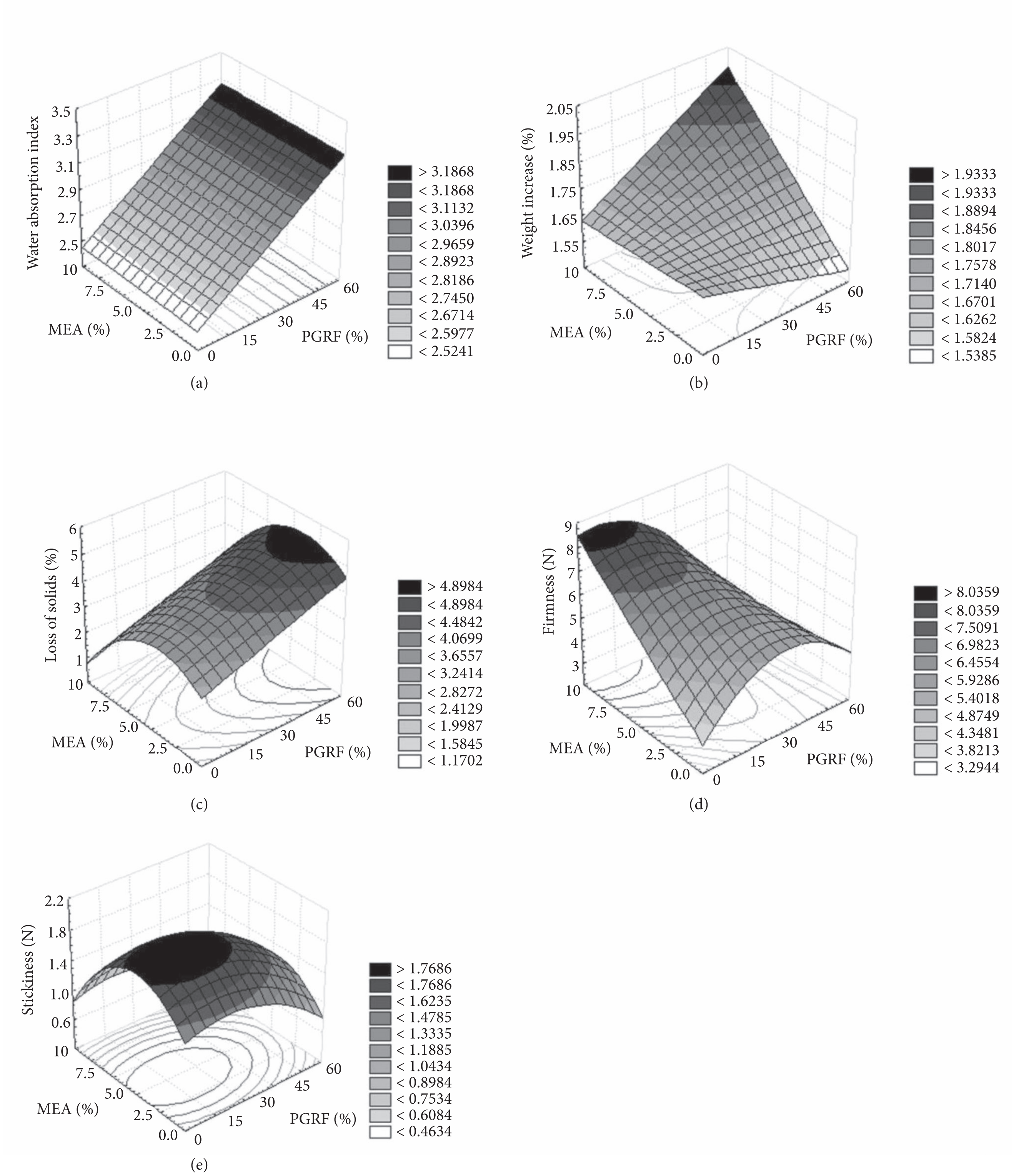

Figure 1. Response surfaces for cooking testing and texture of fresh pasta. a) Water Absorption Index (g centrifugation residue/unsolubilized dry matter); b) Weight increase (%); c) Loss of solids in cooking water (%); d) Firmness (N); e) Stickiness (N). PGRF: pre-gelatinized rice flour; MEA: modified egg albumin.

3.4 Texture

The different formulations exhibited values of firmness between 3.70 N and 10.90 N for the 12 trials (Table 5), with a coefficient of variation (CV) below 14.7%. A firm texture is desirable to prevent rupture during commercialization to prevent disintegration during cooking and to provide the texture known as *al dente* at the time of consumption. The analysis of variance showed a coefficient of determination (R^2) equal to 0.83 and a value of calculated F 2.92 times higher than the tabled F, using 10% significance level. These results validated the mathematical model $y = 6.52 - 0.85 * PGRF - 0.95 * PGRF^2 + 0.69 * MEA - 0.82 * PGRF * MEA$ and allowed the construction of the response surface (Figure 1d).

It was found that the maximum percentage of MEA had a positive effect on the firmness of the pasta. The results obtained in the present study are in agreement with those of Schmiele et al. (2011), who found that the rice pasta became stronger with the addition of modified egg albumin.

It is known that egg proteins, especially albumin, contribute to the formation of a more compact pasta protein network yielding a firmer product with a tougher texture (ALAMPRESE; CASIRAGHI; ROSSI, 2011). According to the supplier's specifications, the modified egg albumin used undergoes a chemical (acidification) and physical (sugar removal) modification that gives the product high gel strength. This feature possibly had a strong influence on the higher firmness of the pasta.

The stickiness of the different formulations of pasta ranged between 0.63 N and 1.89 N for the 12 trials (Table 5), with a coefficient of variation (CV) below 49.5%. The analysis of variance showed a coefficient of determination (R^2) equal to 0.83 and a value of calculated F 2.99 times greater than the tabled F, with 10% of level of significance. These results validated the mathematical model $y = 1.84 - 0.19 * PGRF - 0.16 * PGRF^2 - 0.17 * MEA - 0.34 * MEA^2$ and allowed the generation of the response surface (Figure 1e).

According to these results, it can be seen that the maximum amounts of MEA and PGRF reduced the stickiness of the pasta. Pagani, Resmini and Dalbon (1981), Pagani (1986); Milatovic and Mondelli (1990) showed that the addition of pre-gelatinized rice flour and egg albumin were able to reduce the stickiness of pasta. The pre-gelatinized rice flour favors polymerization with the untreated starch fraction creating a structure that performs functions similar to gluten avoiding the stickiness of the pasta after cooking (PAGANI, 1986; RAINA et al., 2005; CABRERA-CHÁVEZ et al., 2012). In addition, as previously discussed, MEA probably formed a protein network around the starch granules hindering their leaching during the cooking process and thus contributing to lower stickiness of the pasta.

3.5 Experimental validation of the optimum point

According to the response surfaces obtained, MEA had a desirable effect on all evaluated parameters. PGRF had a desirable effect on stickiness and weight increase, only when added in small amounts. In addition, an adverse effect of PGRF was observed on firmness and loss of solids in cooking water. Thus, the values chosen for the optimum point were 10% MEA and 0% PGRF (in coded values, +1.4142 and –1.4142, respectively).

Table 6 presents the predicted values and the results obtained experimentally for weight increase (%), loss of soluble solids (%), firmness (N), and stickiness (N). It can be considered that the results obtained in the experimental validation were satisfactory since the deviations were below 10%.

3.6 Characterization of the optimum point

The proximate composition of the rice fresh pasta without cooking was: protein 15.56% ± 0.27, lipids 0.12% ± 0.006, ash 0.71% ± 0.024, moisture 30.29% ± 0.19, and carbohydrates 53.32%. The rice fresh pasta showed a protein content 3 times greater than that of commercial rice pasta. Therefore, MEA, besides improving the technological characteristics of the pasta, also provided a product with higher protein content. In addition, it was found that the moisture content of the pasta satisfies the limits established by the Brazilian legislation for fresh pasta, which is 35% (BRASIL, 2000).

The analysis of coliforms at 45 °C indicated that the product was processed using satisfactory hygienic-sanitary conditions, according to the current Brazilian legislation, which establishes the absence of this group of microorganisms (BRASIL, 2001).

The count of yeasts and molds in the fresh pasta on the day of processing was 10 CFU/g. After two weeks of refrigerated storage at 4 °C, the count of these microorganisms in the pasta was $1.1*10^3$ CFU/g. Counts of yeasts and molds above $5*10^5$ CFU/g are considered high, making it a health hazard due to

Table 5. Results of cooking test and texture of the 12 trials.

Trials	Weight increase (%)	Loss of solids (%)	Firmness[a] (N)	Stickiness[a] (N)
1	1.65 ± 0.00	2.06 ± 0.24	3.83 ± 0.31	1.49 ± 0.27
2	1.57 ± 0.02	4.75 ± 0.45	4.00 ± 0.35	1.35 ± 0.13
3	1.73 ± 0.02	1.83 ± 0.10	10.90 ± 1.61	1.65 ± 0.28
4	1.91 ± 0.02	2.54 ± 0.11	4.80 ± 0.37	1.11 ± 0.55
5	1.62 ± 0.01	4.00 ± 0.30	6.44 ± 0.72	1.75 ± 0.45
6	1.72 ± 0.03	4.74 ± 0.63	3.70 ± 0.20	1.15 ± 0.13
7	1.60 ± 0.06	4.30 ± 0.40	6.46 ± 0.48	1.54 ± 0.20
8	1.75 ± 0.00	2.30 ± 0.04	6.93 ± 0.53	0.63 ± 0.13
9	1.65 ± 0.03	4.35 ± 0.12	6.78 ± 0.35	1.80 ± 0.14
10	1.68 ± 0.07	4.13 ± 0.03	7.05 ± 0.33	1.61 ± 0.13
11	1.61 ± 0.02	4.14 ± 0.05	6.68 ± 0.71	1.89 ± 0.13
12	1.64 ± 0.03	4.15 ± 0.27	6.44 ± 0.34	1.86 ± 0.24

Arithmetic means of three replicates ± standard deviation. [a]Arithmetic means of seven replicates ± standard deviation.

Table 6. Experimental and predicted values for the optimum point.

Analysis	Experimental value	Predicted value[a]	Deviation (%)
Weight increase (%)	1.80	1.64	9.75
Loss of solids (%)	0.82	0.75	9.33
Firmness (N)	8.24	8.44	–2.30
Stickiness (N)	0.92	0.86	7.55

[a] Predicted values calculated with mathematical models (using coded independent variables).

the production of mycotoxins by molds. In addition, certain food-borne yeasts can trigger allergic reactions and some molds can cause infections in immunocompromised patients (SILVA et al., 2007).

Total counts of aerobic mesophilic and psychrotrophic microorganisms in fresh pasta on the day of processing were $4.1*10^3$ and less than 10^1 CFU/g, respectively. After 14 days of refrigerated storage at 4 °C, there was an increase in the count of these microorganisms, reaching $1.5*10^5$ and $7.7*10^3$ CFU/g, respectively. Brazilian legislation does not set limits for these microorganisms in fresh pasta. If the reference value (BRASIL, 1997) of $2*10^5$ CFU/ml for pasteurized milk (product very conducive to the multiplication of these microorganisms) was used, the fresh pasta would be satisfactory for consumption after two weeks of storage. According to Franco and Landgraf (2008), counts of aerobic mesophilic and psychrotrophic microorganisms exceeding 10^6 CFU/g indicate that the product is already at the stage of deterioration, with possible organoleptic changes and, therefore, inappropriate for consumption.

Based on the results of all microbiological analyses performed during the storage of the product and on the reference data of the Brazilian legislation (BRASIL, 2001), it can be said that the fresh pasta is appropriate for consumption. A total of 14 days of shelf life is possible if the recommendations of use are followed (storage temperature of 4 °C and consumption immediately after opening). This time can be considered adequate since no preservative was used in the production of the fresh pasta.

The sensory characteristics of rice fresh pasta are important for its acceptance by consumers and, therefore, for its commercialization. The average obtained for all parameters in the acceptance test was seven (7 = liked moderately). When the test of purchase intention was applied, it was found that 70% of the panelists would probably buy the product and 16.7% certainly would buy it. These results show good acceptance of the product, and therefore it may be considered an alternative for pasta consumption by celiac patients.

4 Conclusions

Pre-gelatinized rice flour did not satisfactorily affect the technological characteristics of rice fresh pasta. Modified egg albumin showed positive effects on the technological and nutritional characteristics of the product. Microbiological analyses showed that the product can be consumed up to 14 days after processing, provided the consumer follows usage instructions correctly. The sensory analyses demonstrated that the optimum product defined (0% PGRF and 10% MEA) had good acceptance.

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