

## Research Article

### Development of Cookies and Muffins based on Rice, Quinoa and Corn Flours

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**Abstract:** This research aimed to develop cookies and muffins based on a mixture of Rice (RF), Corn (CF) and Quinoa (QF) Flour as alternative bakery products. Three main formulations were used for the elaboration of cookies (F1: 60%RF, 30%CF, 10%QF; F2: 70%RF, 10%CF, 20%QF; F3: 60%RF, 10%CF, 30%QF); while for muffins elaboration two formulations were used (F1:27%RF, 5%CF, 14%QF; F2: 23%RF, 8%CF, 8%QF). Bromatological (ashes, humidity content, protein, fiber and lipids), microbial and sensorial (30 personnel for a non-trained panel with a 9 point hedonic scale) analysis were done to characterize the developed food products. The bromatological results showed the presence of proteins (10.58%), lipids (6.37%), humidity (9.56%), ashes (2.36%), carbohydrates (74%) and a caloric intake of 288 kcal. Muffins presented in their composition: 14% protein, 10% lipids, 14% humidity, 4% ashes, 40% carbohydrate and 320 kcal. Cookies presented the following microbial counts: 200 UFC/g aerobic mesophiles, <3 UFC/g fungi, <4 UFC/g yeast, <3 NMP/g total coliforms and <3 NMP/g fecal coliforms, while muffins presented the following microbial counts: 300 UFC/g aerobic mesophiles, <5 UFC/g fungi, <4 UFC/g yeast, <3 NMP/g total coliforms and <3 NMP/g fecal coliforms. Finally, both products had a positive sensorial acceptance.

**Keywords:** Bakery, bromatological analysis, fortification, innovative food products, nutrition, sensorial analysis

## INTRODUCTION

The recent tendency for healthy food has influenced the development of new food products with increased nutritional value, as well as benefits to consumers. Bakery products are a type of food products characterized by their content of the wheat flour, which allows them to have a bulky structure. This kind of products includes bread, cakes and biscuits, such as crackers and cookies (Martins *et al.*, 2017).

However, bakery products, which are one of the most popular food products among consumers, are not characterized by being healthy. In this regard, the main feature of bakery products is their high caloric intake. In Colombia, 34.5% of the population consumes bread or cookies at least once a day, 27% twice a day and 5% consumes this kind of products three or more times a day (ICBF, 2010).

Nevertheless, the incorporation of functional ingredients into bakery products has attracted increased attention from the food industry due to their positive effect on chronic diseases (Martins *et al.*, 2017). In this regard, the incorporation of rice, corn and quinoa flour in bakery product is particularly interesting due to consumption limitations related to the presence of

gluten in some population groups with coeliac disease. However, the complete replacement of gluten from bakery products is still a technological challenge (Bourekoua *et al.*, 2016).

Rice flour is an interesting raw material for preparing bakery products due to the lack of gluten in its compositional structure and the presence of hypoallergenic proteins (Chinma *et al.*, 2015). Moreover, according to Péterné-Kov and János (1997), the cornstarch can be used, together with xanthan gum, in the preparation of bread, when for dietetic reasons gluten-free flour is required. Additionally, quinoa is a crop typically from the Andean region with nutritional value due to its content of essential amino acid and according to the NASA, quinoa is considered as an excellent crop due to its nutritional value recommended for using during human missions on space (Turkut *et al.*, 2016). Thus, considering the aforementioned advantages of these three flours, the main aim of this research was to develop cookies and muffins based on a mixture of Rice (RF), Corn (CF) and Quinoa (QF) Flour as alternative bakery products. The developed products were characterized according to their macronutrient composition, microbial and sensorial properties.

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Table 1: Formulation for preparing cookies

Ingredient	Formulation (%)		
	F1	F2	F3
Rice flour	60	70	60
Corn flour	30	10	10
Quinoa flour	10	20	30

Table 2: Formulation for preparing cookies

Ingredient	Formulation (%)	
	F1	F2
Rice flour	60	60
Corn flour	30	20
Quinoa flour	10	20

## MATERIALS AND METHODS

Rice, corn and quinoa flour were used as raw materials for the preparation of cookies and muffins, together with powder sugar (100 g), butter (100 g), egg (1 unit) and vanilla flavor (1 tsp). Each ingredient was used according to a specific formulation (Table 1).

On the other hand, two formulations were used for preparing the muffins (Table 2).

The products were prepared as follows: The butter was mixed during 5 min at low speed together with the egg and the vanilla essence until achieving a homogeneous mixture. Following this, rice, corn and quinoa flour were incorporated into the prepared mixture to obtain a homogenous dough. Finally, the obtained dough was placed in metal molds and baked at 180°C during 15-25 min.

**Characterization analysis:** Bromatological, microbiological and sensorial properties of developed products were determined.

All food samples were weighed in an analytical balance (OHAUS AV264C Adventurer Pro Analytical Balance). The water content was determined in a moisture analyzer (Ohaus MB35 AM MB35 Moisture Analyzer). Protein determination was done according to the Kjeldahl method (AOAC, 2000). Lipid determination was done according to the Soxhlet method (AOAC, 2000) and carbohydrate was calculated by mathematical difference.

Microbiological analysis was done in a microbiology certified laboratory in the city of Barranquilla.

The sensorial analysis was done with a panel constituted by 30 non-trained consumers, who used the 9 points hedonic scale to determine the degree of sensorial acceptance of developed products.

**Statistical analysis:** Obtained data were analyzed using ANOVA (5% probability F-test). Moreover, Duncan-test was done at 5%.

## RESULTS AND DISCUSSION

Bromatological results showed that developed products had an interesting content of proteins and

Table 3: Bromatological results

Parameter	Food product content (%)	
	Muffins	Cookies
Protein	14	10.58
Lipids	10	6.37
Humidity	14	9.65
Ashes	4	2.36
Carbohydrates	40	74.00
Caloric intake	320	288.00

Table 4: Microbiological results

Parameter	Food product	
	Muffins	Cookies
Aerobic mesophiles	300 UFC/g	200 UFC/g
Fungi	<5 UFC/g	<3 UFC/g fungi
Yeast	<4 UFC/g	<4 UFC/g yeast
Total coliforms	<3 NMP/g	<3 NMP/g
Fecal coliforms	<3 NMP/g	<3 NMP/g

carbohydrates for both developed products, as well as a considerable caloric intake in 100 g (Table 3).

Moreover, the microbiological analysis showed that the developed food products were safe for consumption (Table 4).

On the other hand, the sensorial analysis showed that formulation 1 and 2 presented characteristics of softness and fluffiness for developed products, cookies and muffins, while the dough had a limited growth in size on products prepared with formulation 3. Thus, formulation 3 was discarded due to limited poor organoleptic characteristics observed after baking. According to Gallagher *et al.* (2004) and De la Hera *et al.* (2013), the gluten has a fundamental role in the elaboration of bakery products because it allows forming dough with special features, such as cohesion, elasticity and extensibility which results consequently in the retention of the gas produced during the fermentation process. However, when there is a lack of gluten in a preparation of bakery products the aforementioned dough's features are difficult to achieve which affects the final sensorial properties of the product. In order to overcome this effect, the effect of incorporating hydrocolloids or other additives such as emulsifiers or acids to the tested product formulation has been studied (De la Hera *et al.*, 2013).

From the techno-functional point of view, Baker *et al.* (2013) have indicated different results from those obtained in this research, indicating that the development of muffins based of quinoa flour as a substitution of part of rice flour in the formulation did not affected the product volume and the percent increase in height when quinoa was incorporated at 30 and 50%, respectively.

Finally, according to the 9 points hedonic scale both products presented a score of 8, which means "like it very much"; therefore, products had a positive sensorial acceptance. Similarly to the results from this research, muffin prepared with quinoa presented good sensory acceptance by consumers (Baker *et al.*, 2013). Moreover, regarding cookies previous work on their

sensory acceptance done by Mancebo *et al.* (2015) have indicated that cookies made with a mixture of rice and corn presented the best sensory scores for the attributes taste, appearance and overall acceptability.

### CONCLUSION

Developed products were safe for consumption from the microbiological point of view. Moreover, the bromatological analysis showed that developed products are an interesting source of proteins, carbohydrate and caloric intake, especially for those consumers that have diet restrictions due to coeliac disease. Finally, the high score obtained in the sensorial analysis indicated that developed products are interesting alternative food products for the general public and because of the lack of gluten especially for those with dietary restrictions.

### CONFLICT OF INTEREST

Authors disclose that there is no conflict of interest.

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