

COOKIES MADE WITH GALACTOMANNANS AND XYLOGLUCANS FROM LEGUMINOSAE SEEDS

COOKIES FEITOS COM GALACTOMANANAS E XILOGLUCANAS DE SEMENTES DE LEGUMINOSAS



Abstract:

The polysaccharides are applied in various foods. These macromolecules are considered as dietary fibers. This work aimed to enrich cookies with regional seeds polysaccharides. Centesimal composition, physicochemical and sensory analysis were carried out for cookies characterization. According to the results, only the protein content did not differ statistically between the cookies. When compared to the standard, the cookie prepared with *Adenanthera pavonina* polysaccharide indicated a greater amount of fiber as well as moisture content. The cookie with polysaccharide of *Hymenaea courbaril* presented more differences when compared to the standard, with a decrease in fat content and acidity in addition to higher moisture and ashes. In physical analysis, it was observed that the cookies in which was added polysaccharide had their thickness increased and their diameter decreased. They also had a smaller weight loss compared to the standard. By sensory analysis the cookie added with *A. pavonina* polysaccharide and the standard cookie had better acceptance. Thus, the *A. pavonina* polysaccharides bring good options for the cookies enrichment, because all the physicochemical analysis' results were within the standards set by the current legislation, there was an improvement in the cookie's physical characteristics.

Resumo:

Os polissacarídeos são aplicados em diversos tipos de alimentos. Estas macromoléculas são consideradas como fibras dietéticas. Este trabalho objetivou enriquecer cookies com polissacarídeos de sementes regionais. A composição centesimal, análise físico-química e sensorial foram realizadas para a caracterização dos cookies. De acordo com os resultados, apenas o teor de proteína não diferiu estatisticamente entre os cookies. Quando comparado com o padrão, o biscoito preparado com polissacarídeo de *Adenanthera pavonina* indicou uma maior quantidade de fibra assim como o teor de umidade. O biscoito com polissacarídeo de *Hymenaea courbaril* apresentou mais diferenças quando comparado ao padrão, com uma diminuição no teor de gordura e acidez, além de maior umidade e cinzas. Na análise física, observou-se que os biscoitos nos quais se adicionou polissacarídeo tiveram sua espessura aumentada e seu diâmetro diminuído. Eles também tinham uma perda de peso menor em comparação com o padrão. Pela análise sensorial, o cookie adicionado com o polissacarídeo de *A. pavonina* e o cookie padrão tiveram melhor aceitação. Assim, os polissacarídeos de *A. pavonina* são boas opções para o enriquecimento dos biscoitos, pois todos os resultados da análise físico-química estavam dentro dos padrões estabelecidos pela legislação vigente, houve melhora nas características físicas do biscoito.

**Francisca Andrea Kercia Silva,
Nayanne Lima dos Santos,
Jéssica Roberta Pereira Martins,
Maria Juciene Lima Chaves,
Renata Chastinet Braga¹**

¹Instituto Federal de Educação Ciência e Tecnologia do Ceará, Campus Limoeiro do Norte. E-mail: rchastinet@gmail.com

Contato principal
Renata Chastinet Braga¹



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INTRODUCTION

Fiber is the portion of plants, or analogous carbohydrates that are resistant to the digestion and to absorption in the human small intestine with complete or partial fermentation in the large intestine. This term includes polysaccharides, lignin, oligosaccharide and associated plant's substances promoting physiological benefits (DHINGRA et al, 2012). They affect the metabolism of certain nutrients and some diseases regulation. These properties refer to the polysaccharide chains conformation and the way they interact with other diet components (BRENNAN, 2005).

The fibers are classified according to their solubility in water as soluble and insoluble. Soluble fibers correspond to the pectic substances, the glucans, gums and mucilages, some hemicellulose and the psyllium (MIRA et al.2009). They can act in the stomach and in the small intestine increasing the satiety as well as the bolus viscosity, and decreasing the activity of certain digestive enzymes, directly influencing the digestion and nutrients absorption rate (ENDRESS, FISCHER 2001). It is directly related to the decrease of the blood postprandial glucose levels (ANTILLA; SONTAG- STROHM; SALOVAARA, 2004).

Studies have shown their beneficial effects on health and disease prevention. The recommended total dietary fiber intake should be from 20 to 35g per day or 10 to 14g of fiber/1000 kcal. Among the benefits attributed to the adequate dietary fiber intake, it was also noticed a decrease in cholesterol; constipation preventing; satiety increasing; reducing the risk of type 2 diabetes and cardiovascular diseases; diverticulosis prevention and treatment from type 1 diabetes (DHINGRA et al, 2012).

The Brazilian socioeconomic profile improvement has led to the consumption decrease of fiber foods sources, due to the replacing by industrialized, and the current modern lifestyle, in which everything must be done without requiring long time (CATALANI et al., 2003). The use an easily consumed and accepted food is a way out to compensate the low intake of fiber by Brazilians. Then, the use of cookies as a functional food was considered.

The country stands out in this product production. In 2009 it ranked the second position in the world ranking, producing about 1,177 million tons of biscuits (SIMABESP, 2008). There are the cookies, which have a relatively long shelf life, are wanted for people of all ages and have good acceptance (CAUVAIN, 2017).

In addition to having an extended shelf life, in low humidity, cookies have a variety of formulations and well accepted by children (SILVA; DA SILVA; CHANG, 1998). James, Courtney e Lorenz (1989) reported that due to the size existing nutritional appeal regarding food, cookies has been formulated with a view to implementing its fortification with fiber or protein.

Some fibers example are the polysaccharides, there may be mentioned the galactomannans and xyloglucans, present respectively in the seeds of *Adenanthera pavonina*

(Carolina) and *Hymenaea courbaril* (Jatobá). These two species are distributed throughout the Brazil Northeast region. Xyloglucans and galactomannan are widely used in food industry, but galatomannan from *A. pavonina* and xyloglucan from *T. indica* are not explored. These materials are rarely used by the food industry due to the lack of knowledge of their potential, especially when it comes to nutritional value.

There is a real possibility of production of natural polysaccharides, serving as an alternative to existing products, but there is a gap between research groups studying polysaccharides of interest and companies that produce and export polysaccharides that the market needs, space that urgently needs to be filled (CUNHA; DE PAULA; FEITOSA, 2009).

Considering this scenario, the present study aims to apply regional seeds' polysaccharides, targeting cookies enrichment, and also determining product's physical, physicochemical and sensorial characteristics.

MATERIAL AND METHODS

Obtaining the polysaccharide

The polysaccharides were obtained by the aqueous extraction in ethanol following the method described by Braga et al (2011). Were used for extraction, *Adenanthera pavonina* seeds (SAP) and *Hymenaea courbaril* seeds (SHC) acronym in Portuguese. The seeds were submitted to boiling, in distilled water on a heater plate for approximately thirty minutes for SAP and three hours for SHC. Was made the manual separation of endosperm of SAP and cotyledon of SHC, it was liquefied in distilled water and allowed to settle in a test tube overnight. Thereafter, they were centrifuged and precipitated at the ratio of 1: 2 to SAP and 1:3 for FHC (v/v) ethanol. After twenty-four hours, the precipitate (polysaccharides) was immersed in acetone for 24 hours to eliminate water and alcohol. After this process, the polysaccharides were dried with the aid of the vacuum pump and then they were macerated. After obtaining the polysaccharide, this product was used in the cookie formulation. The flowchart can be observed in Figure 1.

Cookies formulation

The formulations were developed through the 10-50D method described by AACC, 1995, with some modifications, in this case, the polysaccharide addition. The cookies elaborated were called A-type and B-type being respectively composed by polysaccharides of *Adenanthera pavonina* and *Hymenaea courbaril*, both present in a 10% in the cookie type biscuit. A basic formulation for the pattern was developed without the addition of polysaccharides and was named Standard, as shown in Table 1.

Figure 1 - Polysaccharide flowchart extraction.

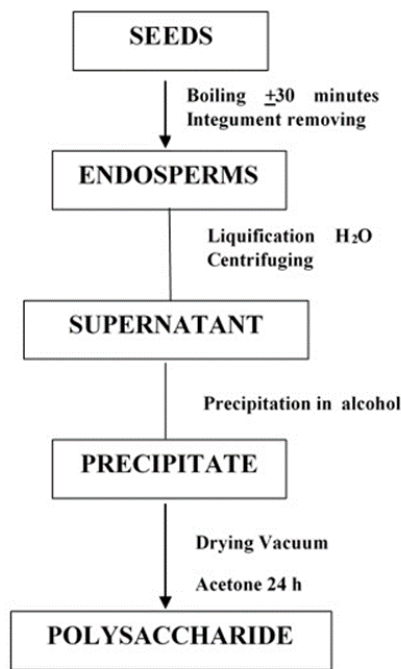


Table 1. Standard, A-type and B-type cookies formulation.

Ingredients	COOKIES		
	STANDARD (g)	A-TYPE (g)	B-TYPE (g)
Wheat Flour	100	90	90
*PAP	-	10	-
**PHC	-	-	10
Sugar	55	55	55
Margarine	50	50	50
Water	5	8	8
Chemical Baking Powder	2,5	2,5	2,5
Salt	0,7	0,7	0,7

*PAP – *Adenanthera pavonina* flour.

**PHC – *Hymenaea courbaril* flour.

In the Figure 2 we can observe the cookies preparation flowchart in which an electric mixer for domestic use was utilized for the processing of the cookies dough. Initially the margarine, the sugar, the salt and the chemical baking powder were mixed at low speed for three minutes. Then the corresponding quantity of distilled water was added and the dough was mixed at low speed for one minute at medium speed for one minute. After adding all the flour and the polysaccharide the dough continued being mixed for two more minutes on low speed.

Figure 2 – Cookies flowchart production.

The dough was placed in a pan biscuit, equipment used to give the cookies their form. They were baked at 150 °C for twenty five minutes. Immediately after leaving the oven, they were cooled to room temperature and packaged. The cookies used for this analysis were from three different batches of the same formulation.

Cookies physical analysis

The cookies physical characteristics were determined by the 10-50D method of the AACC 1995, from which was determined the weight loss by the weight variation before and after cooking. The yield was calculated based on weight. The diameter and the thickness of the cookies were determined using a caliper. The analysis was performed with five cookies, from the same batch, chosen at random, after reaching ambient temperature. The expandability coefficient is given by the ratio between the cookie's diameter and thickness. All the analysis was performed in triplicate.

Cookies physicochemical analysis

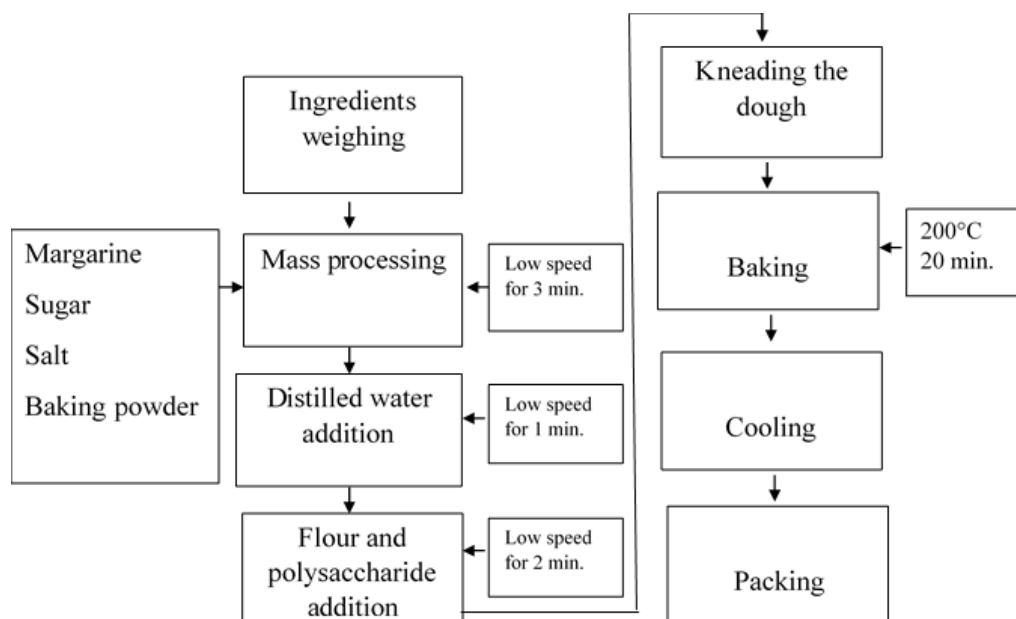
The polysaccharides and the cookies chemical composition were determined by the following procedures: moisture in stove at 105 °C to constant weight, ashes on incineration at 550 °C, lipids by solvent extraction method (Soxhlet Method) as methodologies proposed by the Adolfo Lutz Institute (1985). The total nitrogen was determined by the Kjeldahl Method and converted in gross protein by the factor of 5.75, according to AOAC (1990). The crude fiber was determined from the acidic and basic hydrolysis in a fiber analyzer of brand ANKON® model - A200I. According analytical techniques described by Instituto Adolfo Lutz (IAL, 2008). All the analysis was performed in triplicate.

Cookies Sensorial Analysis

The analysis was performed in the IFCE Limoeiro do Norte campus Sensorial Analysis Laboratory, with 100 untrained food tasters, randomly selected, of which were included students and employees of the institution of both sexes. The acceptance of the cookies formulated with and without the polysaccharide addition was evaluated by means of an affective laboratory test. The evaluators reported how they liked or disliked each cookie using a 9-point hedonic scale ranging from "I liked very much" (maximum score) to "I disliked very much" (minimum score), following the methodology described by Dutcosky, 1996.

Statistical Analysis

The experimental results were analyzed by analysis of variance (ANOVA) and the averages were compared by Tukey test, at the 5% significance level.



RESULTS AND DISCUSSION

Yield of the polysaccharide of *Adenantha pavonina*

There were obtained a 4.81% percent yield in relation to the used seed mass (30.09g). This value was much lower than those found by Passos et al (2016) and Cerqueira et al (2009b) who obtained a 14,05-19,96% and a 17% yield, respectively.

Yield of the polysaccharide of *Hymeneae courbaril*

A 36.30% yield was obtained, in relation to the used seed mass (14g), with 5.08g of xyloglucan. The result was higher than that found by Redeschi (2006), who achieved a 34.62% yield in relation to the total seed mass by aqueous extraction. But the present work's yield is considered low compared with other authors' results, such as Lima et al (1993) who obtained an approximately 45% yield.

Composition of the polysaccharide

It can be seen in table 2 the composition of *A. pavonina* and *H. courbaril* polysaccharides. It is noticed that they contain appreciable amounts of protein, but the PHC (Polysaccharide of *Hymeneae courbaril*) has higher values. In relation to the moisture, it was observed that the PAP (Polysaccharide *Adenantha pavonina*) contains a great moisture content and low ashes content, especially when compared to the PHC. The lipids showed higher percentages in PAP but the oscillations indicated that it is not a statistically significant difference. Anyway, it is a healthy fat since it is derived from a vegetable source.

Table 2. Elementary Polysaccharide Composition.

Elementary Analysis (%)	PAP	PHC
Moisture	13,78 ^a	10,66 ^b
Ashes	0,24 ^a	1,83 ^b
Proteins	1,32 ^a	6,77 ^b
Lipids	0,12 ^a	0,05 ^a

The averages followed by the same letter are not statistically different from each other.

Cookies chemical characterization

The results of the chemical analysis of the Standard cookie and the sample of A-type and B-type cookies can be verified in Table 3.

Statistically, it was possible to observe significant differences in the analyzed samples. In Table 3, the results for moisture in the cookies added with polysaccharides showed higher values when compared with the standard, though both differed statistically. All the results were considered low, what is advantageous for the food industry since it has longer shelf-life.

Table 3. Standard, A-type and B-type characterization.

Cookie	STANDARD (%)	A-TYPE (%)	B-TYPE (%)
Moisture	2,13 ^a	3,92 ^b	3,24 ^c
Ashes	2,31 ^a	2,31 ^a	2,08 ^b
Protein	5,34 ^a	5,77 ^a	5,41 ^a
Lipids	16,98 ^a	17,50 ^a	10,62 ^b
Fiber	1,58 ^a	1,75 ^b	1,56 ^a

The averages followed by the same letter are not statistically different from each other.

The results of ashes were very similar to the analyzed samples, the values were around 2.08 and 2.31, but there was a significant difference between the Standard and the A-type compared to B-type, which showed lower values,

however the results found are within the range set by the (CNNP, 1978), which requires a fixed amount for mineral residue around 3%. Silva et al. (1999) obtained ashes, lipids and moisture values similar to the A-type sample, working with cookies enriched with Jatobá flour. When the Standard and A-type cookies' formulations' lipids and fibers were analyzed the results came out similarly to Gutkoski et al. 2007 who also observed this change, the author found significantly higher levels of fibers and lipids in the formulation with higher levels of oat flakes and of β -glucans concentrate, the lowest values were found in those who had higher of wheat flour concentration. In the B-type cookie reduced levels of both lipids and fiber were noticed when compared to the others. In Table 3, it was found that the fibers values are higher in cookies added with polysaccharide, when compared to the standard, these values should be higher, it hadn't happened due to the analysis low sensitivity, since the method used is the Henneberg's (1985), which only measures the gross fiber. Taking into consideration that the *Adenanthera pavonina*'s galactomannans and *Hymeneae courbaril*'s xyloglucans are soluble fibers which implies that much was lost during the analysis performing, since the sample is submitted to acid and then to basic medium, thus much of the soluble fraction has been destroyed and only a small part of it was quantified.

In Table 3 the values for acid titration were verified, of which it was observed a small difference between the

cookies, it was noticed that the samples of cookies added with polysaccharide *A. pavonina* and the Standard did not differ statistically, on the other hand, the cookies added with *H. courbaril* had lower values than the others. However, both were within the established by the legislation that requires a maximum of 2.0 mL/100g (CNNP, 1978) of acidity in normal solution. In the study performed by Kopper et al (2009), higher values were found in adding bocaiuva flour into cookies, especially when comparing the lipids, moisture and protein content. On the other hand, the ashes were lower and the fibers were similar to the cookies added with polysaccharide.

Cookies physical characteristics

As can be seen in Table 4 it was found that before to the cooking process the cookies added with polysaccharide statistically differed from the pattern. As in relation to the diameter, it can be observed that the B-type and the Standard samples were significantly different and the A-type sample was in the range. In thickness, there was no difference in the three samples. After the cooking process, as shown in Table 4, it was observed that the cookies added polysaccharide were thicker than the standard, but the later had a higher diameter, this must be due to polysaccharide characteristics, since the same is considered a soluble fiber, acting in the water retention and preventing dough spreading.

Table 4. Standard, A-type and B-type cookies before and after the cooking process

	Before cooking			After cooking		
	Standard	A-Type	B-Type	Standard	A-Type	B-Type
Weight (cm)	18,57 ^b	20,20 ^a	20,33 ^a	16,63 ^b	18,51 ^a	17,73 ^a
Diameter (cm)	4,56 ^b	4,58 ^b	4,80 ^a	5,36 ^a	5,20 ^a	5,18 ^a
Thickness (cm)	0,40 ^c	0,48 ^b	0,82 ^a	0,62 ^c	0,76 ^b	1,10 ^a

The averages followed by the same letter are not statistically different from each other

It was also observed a decrease of both cookies weight, the Standard had a yield of, on average, 89.52% while the cookies added with polysaccharide of *Hymeneae courbaril* and *Adenanthera pavonina* had around 87.58% and 91.60% respectively, although this last has obtained superior values compared to the others, demonstrating their smaller mass loss and bigger water retention capacity, there were no significant differences between the samples. Fasolin, 2007 observed opposite results with the cookies with partial replacement of wheat flour by green banana flour (GBF), in other words, the cookies added with the GBF presented lower retention capacity when compared to the standard, according to the author these values were directly related to the high Standard cookie hygroscopicity.

The spread factor is the ratio between the cookies diameter and its thickness being obtained here values in

between 4.70 and 8.77. The Standard Cookies obtained higher values, followed by the cookie added with *A. pavonina* and *H. courbaril*, considering that the size and the weight are directly related to the expansiveness coefficient. Despite the use of a cookies pan providing standardization, this did not happen due to the difference of dough consistency.

Sensorial Evaluation

The results of variance analysis applied to the results obtained by sensorial analysis are observable in Table 5.

Table 5. Variance Analysis of the Sensorial Analysis

Sources of variation	GL	SQ	QM	F
Sample	2	21	10,56	8,05*

Food Taster	99	83	3,16	2,41
Residue	198	97,1	1,31	

*= Is is not significant
GL= Degrees of freedom;
SQ= Sum of Squares;
QM= Mean;
F= Estimation;

It was observed that among the examined cookies samples exists a significant difference in a 5% level, calculations obtained using ANOVA. After performed ANOVA it was found that F calculated > F tabulated.

In general, it was observed that the samples obtained satisfactory acceptance because the average ranged from the note 6 – which in the hedonic scale corresponds to the item “I liked slightly” and 7 “I liked moderately”.

When applied the Tukey test ($p < 0.05$) and compared the averages between the samples, there were no differences between the A-type and the Standard cookies, but the A-type and B-type samples, as well as Standard and B-type, when compared their averages, some significant differences were observed in a 5% level, in other words, the tasters were able to identify differences between the B-type and the other samples.

When taken into consideration the lowest average of the B-type cookie, it was noticed that cookies added with Jatobá polysaccharide had less acceptance when compared with A-type and Standard samples.

Thus, the addition of polysaccharide *A. pavonina* can be performed without causing damage to the product, since the tasters did not noticed significant differences between the cookies added with this polysaccharide and the Standard one. However, more studies should be performed to corroborate the taster’s perception in relation to the cookies added with Jatobá polysaccharide, since the polysaccharides do not leave any residual flavors.

CONCLUSION

The polysaccharides are good options in the cookies enrichment because even with differences between the obtained values, all were within the standards set by the current product legislation.

The results for fibers were higher in cookies added with polysaccharides of *Adenantha pavonina* when compared to the others. It was also observed improvements in the physical characteristics of the product, especially in relation to the dough, because the cookies added with polysaccharides obtained higher yield compared to the standard, due to the characteristic of these macromolecules to absorb water.

The results of the sensorial analysis show that the cookie enrichment with the polysaccharide *A. pavonina* can be performed on the product without, however, modifying its characteristics for the consumer, since they have not been able to identify this change, when compared to standard which was verified by applying the Tukey test. The

cookies added with Jatobá, there was a 5% difference when compared with the other cookies.

Thus, the cookies enrichment with polysaccharides can be a good alternative because it is an easily obtained low-cost product and it is widely available in nature. It is advantageous for food industries to have the alternative of introducing a new source of soluble fiber in its products.

Some studies can also be performed by checking that perception of the food tasters regarding the cookies added with polysaccharide of Jatobá, since this compound does not leave residual tastes in the product to which is added.

The formulation of a cookie with fiber of using the local biomass would also be interesting, one option would be adding dehydrated cashew waste to this product, since every year tons of waste are discarded by the pulp and juice industry. As it is an insoluble fiber, the polysaccharide could also be added with those as soluble fiber source. This would be a form of local development that would bring benefits to local population.

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