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Elaboration and acceptability of restructured hams added with jabuticaba skin

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Abstract

Jabuticaba skin flour (JSF), rich in antioxidants and fibre, was used in order to develop four restructured hams in different combinations with meat: 0% control – without the addition of JSF, with the addition of 0.5% JSF, 1.0% JSF and 1.5% JSF, meeting, therefore, the growing demand for meat products with functional appeal. Physicochemical characterizations and sensory analysis were performed, evaluating the impact of information on possible health benefits and the effect on storage. Restructured hams with JSF had higher contents of phenolic compounds; greater weight loss; a darker shade; texture profile with smaller parameters of stiffness, cohesiveness, adhesiveness, flexibility and chewiness (except the restructured ham with 0.5% JSF). Phenolic compounds, pH values, colour and TBARs did not differ with storage time, but were statistically different among JSF concentrations. Panellists preferred the restructured ham without JSF, however, the analysis of variance for overall aspect did not show a significant difference between the restructured ham "control" and those added with 0.5% and 1.0% JSF, after informing the panellists that they would possibly bring health benefits. It is concluded that it is possible to prepare and store restructured hams with JSF, at concentrations of 0.5% and 1.0% with good acceptance.

Keywords: *Plinia jaboticaba*; meat product; dietary fibre; phenolic compound; antioxidant; sensory analysis.

Practical Application: Jabuticaba skin flour, rich in antioxidants and fibre, was used in order to develop four restructured hams in different combinations with meat. The jabuticaba skin waste was dried and ground, and then added to the restructured ham in various concentrations, resulting in a product with a higher content of antioxidant substances and fibre, which can bring benefits to consumer health. In the sensory analysis, it was possible to observe the acceptability of restructured hams containing the jabuticaba skin at concentrations of 0.5% and 1.0%.

1 Introduction

The demand for healthy, nutritious and safe food has been growing worldwide, and a balanced food intake is the correct way to prevent or even remedy health problems, such as obesity, diabetes, malnutrition, cardiopathies and others, which largely originate from dietary mistakes (Marques et al., 2015).

Due to this fact, there is a growing interest by the food industry and consumers in using natural ingredients obtained from fruits and their waste (skins, seeds and bagasse), which may contain fibre, minerals and substances with antioxidant, antimicrobial, anti-inflammatory and anticancer activities, for the production of new products.

Jabuticaba is one of the fruits that have these substances, especially in its skin and is appreciated for both fresh consumption and jelly manufacturing, fermented beverages and vinegars (Citadin et al., 2010). According to Agricultural Economics Institute (IEA – Instituto de Economia Agrícola, 2012), jabuticaba planting in São Paulo/Brazil held 270 hectares in 2012, which yielded 2560 tons of the fruit.

Jabuticaba skins, that represent up to 43% of the fruit and are usually discarded, have high contents of phenolic compounds (11.99 g 100 g^{-1} dry matter (DM)), as well as dietary fibre (soluble fibre – 6.8 g 100 g^{-1} DM and insoluble fibre – 26.43 g 100 g^{-1} DM), and minerals, in mg 100 g^{-1} DM, such as iron, 1.68; potassium, 1,496.67; magnesium, 90.00 and manganese, 1.71 (Lima et al., 2011a).

The application of jabuticaba skin flour (JSF) show a beneficial effect in reducing risk of development of insulin resistance associated with obesity (Lenquiste et al., 2012; Araújo et al., 2014). In addition to its high antioxidant capacity (Batista et al., 2014), *in vitro* antiproliferative and *in vivo* antimutagenic potential (Leite-Legatti et al., 2012), as well as antimicrobial (Silva et al., 2014) and hypocholesterolemic effect (Alezandro et al., 2013).

Due to the benefits that the flour can bring to health, its use is very relevant in the development of new products as a source of phenolic compounds, fibre and minerals and as an option in the fight against the waste of this important raw material. Furthermore, it enriches the diet of the population and meets the interests of consumers for products with added nutritional value.

In Brazil, the consumption of restructured hams has become popular, since they are products made with raw materials less noble than ham and are still quality products, with a lower cost. Concomitant to the growing consumption, the concern among

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public health agencies has grown, with the increasing onset of chronic diseases. Therefore, the presence of fibre in meat products is of great interest in health care (Talukder, 2015). Moreover, due to the phenolic compounds present in JSF, their addition to meat products will increase antioxidant activity, which can bring benefits to consumer's health. In this context, jabuticaba skins appear as an option to add value to meat products, due to their bioactive substances. Therefore, the objective of this study was to develop restructured hams with the partial substitution of meat by jabuticaba skin flour (JSF), performing physicochemical and sensory characterizations, assessing the impact of information the fibers and phenolic compounds would bring on possible health benefits and the effect of the use of JSF on product storage.

2 Material and methods

2.1 Jabuticaba harvest and preparation of skin flour

Ripe jabuticaba (*Plinia jaboticaba* (Vell.) Berg) fruits, Sabará genotype, were hand-picked in the municipality of Coqueiral, MG, Brazil. Healthy fruits were selected, washed to remove impurities and sanitized with a sodium hypochlorite solution (200 mg kg^{-1}); the jabuticabas were pressed and the skins were separated. They were placed in fine mesh metallic material baskets and dehydrated at a temperature of 45 °C in a forced air oven, until constant weight. After drying, the skins were ground in a knife mill (TE 631 Tecnal) for 3 minutes, passed through 35-mesh sieves and the obtained flour was stored in polyethylene flasks, wrapped with aluminum foil and stored at room temperature until the preparation of the restructured hams.

2.2 Preparation of restructured hams

The meats, refrigerated (4 °C), were cleaned (removal of trims and cartilage) and ground in a 14-mm disk. The ingredients (Table 1), including JSF, were mixed until complete homogenisation and the obtained mixture was kept in a cold chamber (4 °C) for approximately 20 hours, for the curing process. The difference between the tratments was the meat replacement per JSF at the different concentrations.

The obtained mixture was then vacuum-packed in nylon-poly flexible film and shaped into a 1 kg metal form. Four restructured hams were elaborated in different combinations with meat: 0% control – without the addition of JSF, with the addition of 0.5% JSF, 1.0% JSF and 1.5% JSF in three replicates.

The restructured hams were cooked in a pan with heated water, according to the following schedule: 60 °C/60 minutes, 70 °C/60 minutes and 80 °C/20 minutes until the internal temperature reached 72 °C. After cooking, the forms were immersed in water and ice (0 °C), and unformed and conditioned, under refrigeration (4 °C), for further analysis.

2.3 Analyses of restructured hams

The content of moisture, lipids, crude protein (N × 6.25), ash and carbohydrates of restructured hams was performed in three replicates, according to the official methodology of the Association of Official Analytical Chemists (2012). The content of dietary fibre in jabuticaba skin flour was performed (Association of Official Analytical Chemists, 2012) to calcular the content dietary fibre of restructured hams. The calculation of the caloric value of restructured hams was performed using ATWATER factors (carbohydrates = 4.0; lipids = 9.0; protein = 4.0).

Table 1. Basic formulation for the preparation of restructured hams.

	0% JSF* (control)		0.5% JSF	1.0% JSF	1.5% JSF
Raw material	g	%		g	
Pork shoulder	430.5	43.05	427.0	423.5	420.0
Pork shank	184.5	18.45	183.0	181.5	180.0
JSF (g)	-	-	5	10	15
Water (mL)	310	31	310	310	310
Supro 500E (soy protein isolate)	20	2	20	20	20
Cassava starch	20	2	20	20	20
Refined salt	10	1	10	10	10
Rendmax 208 (mix containing phosphate, nitrite/ nitrate, and ascorbate/ isoascorbate)**	17	1.7	17	17	17
Max sabor 207 (monosodium glutamate)	3	0.3	3	3	3
California ham condiment	5	0.5	5	5	5
Carmine dye (mL)	0.1	-	0.1	0.1	0.1

*JSF = jabuticaba skin flour; **New Max industrial.

Average pH values were measured using a potentiometer (Digimed, DM 20, São Paulo, Brazil), by inserting a combined penetration electrode into the product at three different points.

Restructured ham samples were weighed in three replicates before cooking. The packed pieces were kept at 4 °C. After 24 hours, the packages were removed and the pieces were dried with absorbent paper for the determination of weight loss, using the Equation 1 below.

$$WLC\ (\%) = (IW - FW)/IW \times 100 \qquad (1)$$

Where: WLC = weight loss on cooking; IW = initial weight of the restructured ham; FW = final weight of the restructured ham

Water activity (Aw) of restructured hams was directly evaluated using a specific CX2 Aqualab® apparatus, for the determination of the dew point (Association of Official Analytical Chemists, 2012).

The extraction of phenolic compounds of the restructured hams was performed with 50% methanol (1:50, w v^{-1}), and subjected to determination, using the Folin-Denis reagent (Association of Official Analytical Chemists, 2012). Tannic acid was used as a standard.

The analyses of thiobarbituric acid reactive substances (TBARs) were performed on the restructured hams after storage under refrigeration (4 °C) for 24 hours (Jorge et al., 2015).

The colour indices L*, a* and b* of restructured hams were obtained for each repetition using in a spectrocolorimeter

(Konica Minolta, CM-5), with the following characteristics: 30.0 mm measurement area, 10° angle of view, illuminant D65 with specular component included. Considering the average value of six readings, taken at different points of three slices (replicates) of approximately four centimetres in thickness.

The restructured hams were analysed at room temperature by texture profile analysis (TPA), using a texturometer TA.XT2i Texture Analysis (Stable Micro Systems Inc.), connected to a computer equipped with the Texture Expert® program. Texture profile analysis (TPA) was conducted according to Pereira et al. (2011). The samples, cut into 1.0-cm cubes, were compressed twice to 50% their size. The curve of deformation over time was obtained at a compression speed of 2.5 mm s^{-1}, from which five texture features were generated, according to Ramos & Gomide (2007): stiffness; cohesiveness; adhesiveness; flexibility and chewiness.

2.4 Storage of restructured hams

For storage, the restructured hams were unmolded, after cooled in an ice bath, and cut into pieces of approximately 200 g, vacuum packed and stored under refrigeration (4 °C) at times 0, 15, 30, 45 and 60 days, and the following analyses were carried out: lipid oxidation, pH, objective colour and phenolic compounds.

2.5 Sensory analysis

The sensory analysis was approved by the Ethics Committee on Human Research of Universidade Federal de Lavras – UFLA, under the certificate number for ethical consideration (CAAE): 13068013.4.0000.5148. Was prepared four types of restructured hams: without addition of JSF (control) and adding the JSF at concentrations of 0.5%, 1.0% and 1.5% and were analysed by the CATA test – Check-all-that-apply, according to Ares et al. (2010).

Fifteen untrained panellists randomly selected were invited to taste each of the restructured ham samples, which were cut into slices of 10 cm square. The panellists used words they considered appropriate to describe the features responsible for sensory differences. Fourteen attributes were selected for the CATA test, divided into four categories: 1) appearance: bright surface, dull surface, brownish colour, pink colour; 2) aroma: characteristic aroma of restructured ham, mild aroma of restructured ham; 3) flavour: characteristic flavour of restructured ham, smoother flavour of restructured ham, sour taste; and 4) texture: firm, soft, crumbly, dry, juicy.

In the second stage, the analysis was performed in individual cabins, with the participation of 97 untrained panellists, restructured ham consumers, aged between 18 and 60 years, 65 females and 32 males. The CATA test was presented to the panellists along with a nine-point hedonic scale proposed by Ares et al. (2010), whose scores ranged from 1 (disliked extremely) to 9 (like extremely), coded with three random numbers in monadic sequence, and the panellists evaluated five parameters: appearance, aroma, flavour, texture and overall aspect without information on what possible benefits the addition of JSF could bring.

In the third stage, the panellists were informed that the increasing addition of JSF would possibly add a higher antioxidant activity and dietary fibre content to the ham, and bring health benefits, and they were asked again to score the overall aspect of the different restructured hams.

2.6 Experimental design

The analyses weight loss on cooking and sensory analysis were performed at time zero, while the analyses lipid oxidation, pH, objective colour and phenolic compounds were subjected to a completely randomized design with 4 treatments and 5 times (0, 15, 30, 45 and 60 days), using the computer program SAS (SAS Institute, 2008). When the analysis of variance showed significant difference, the comparison of means by Tukey's test at 5% probability was made.

The analyses proximate composition, water activity and texture were performed at time 30 days. Physical and chemical analyses were performed in duplicate for each repetition, except for objective texture, which was carried out in five replications for each repetition. Data were subjected to analysis of variance and, when significant, the means were compared by Tukey's test, considering 5% significance. These analyses were conducted in SAS (SAS Institute, 2008).

For the statistical analysis of the acceptance tests, a completely randomized design with four treatments (four concentrations) and 97 panellists was used. When the analysis of variance showed significant difference, Tukey's test was used to compare means at 5% probability. Data from the CATA test were organized in a matrix with the frequency at which the attributes were cited, and subjected to principal component analysis (PCA).

3 Results and discussion

3.1 Restructured hams

There was a lower moisture content in the restructured ham added with 1.5% JSF (70.46 g 100 g^{-1}), which differed statistically from those found in restructured hams added with 0.5% JSF, 1.0% JSF and control (Table 2). However, they were all within the recommended standard for restructured hams, which is until 75% (Brasil, 2000).

Restructured hams prepared with different JSF concentrations did not differ statistically from the control in relation to lipids (Table 2) and showed contents far below the maximum standard recommended by Normative Instruction Nº 20, from 31/07/2000 (Brasil, 2000), which is 12%. According to Ordinance Nº 27/98, from Ministry of Health - Health surveillance (Brasil, 1998), restructured hams are within the standards to be considered "low" in total fat, since the legislation mentions that Brazilian products should have no more than 3 g fat 100 g^{-1} food (for solids).

For protein contents, there was no difference between the restructured hams. The ash content for restructured hams added with 1.5% JSF was lower than the added with 0.5%, not differing from the others; minerals were probably leached with water, since water loss was higher in this ham restructured. The higher carbohydrates content was found in the restructured ham added

Table 2. Chemical and physical composition of the different restructured hams.

Constituent	Restructured ham[1]				CV(%)
	0% (control)	0.5%	1.0%	1.5%	
Moisture (g 100 g^{-1})	72.67 ± 0.98 a	73.25 ± 0.50 a	72.88 ± 0.61 a	70.46 ± 0.49 b	0.93
Lipids (g 100 g^{-1})	3.27 ± 0.08	2.56 ± 0.50	2.67 ± 0.23	2.87 ± 0.32	11.20
Crude protein (g 100 g^{-1})	11.47 ± 0.38	11.84 ± 0.39	11.65 ± 0.56	12.12 ± 0.14	3.37
Ash (g 100 g^{-1})	5.19 ± 0.41 ab	5.25 ± 0.38 a	4.62 ± 0.24 ab	4.14 ± 0.53 b	8.41
Carbohydrates (g 100 g^{-1})	7.4 ± 0.76 b	7.1 ± 0.48 b	8.18 ± 0.72 b	10.41 ± 0.44 a	2.86
Insoluble fibre* (g 100 g^{-1})	0	0.15	0.30	0.45	
Soluble fibre* (g 100 g^{-1})	0	0.02	0.04	0.07	
Total fibre* (g 100 g^{-1})	0	0.17	0.34	0.52	
Caloric value (g 100 g^{-1})	104.94 ± 0.25 b	98.86 ± 0.51 c	103.28 ± 0.42 b	115.82 ± 0.17 a	2.41
pH	6.03 ± 0.15 a	6.01 ± 0.19 a	5.83 ± 0.04 b	5.67 ± 0.12 c	2.13
Weight loss on cooking (%)	3.17 ± 0.00 c	3.00 ± 0.00 c	5.50 ± 0.01 b	14.83 ± 0.01 a	8.98
Water activity	0.97 ± 0.00	0.97 ± 0.00	0.97 ± 0.00	0.97 ± 0.00	0.00
Phenolic compounds (mg 100 g^{-1})	90.00 ± 8.75 d	130.05 ± 13.16 c	170.27 ± 8.72 b	250.20 ± 6.76 a	8.34
TBARs (mg malonaldehyde kg^{-1})	0.30 ± 0.02 c	0.37 ± 0.03 bc	0.46 ± 0.05 ab	0.48 ± 0.02 a	7.29

[1]0% (control): without the addition of jabuticaba skin flour (JSF); 0.5%: addition of 0.5% JSF; 1.0%: addition of 1.0% JSF and 1.5%: addition of 1.5% JSF. *Calculated according to the content of dietary fibre in jabuticaba skin flour (Insoluble fibre: 30.02 g 100 g^{-1}; soluble fibre: 8.90 g 100 g^{-1} and total fibre: 38.92 g 100 g^{-1}). Data are the mean of three replicates ± standard deviation. Different letters in rows differ by the Tukey test (P ≤ 0.05).

with 1.5% JSF that occurred due to a greater loss water and ash in this formulation.

Regarding the total dietary fiber content, restructured hams added with 1.0% and 1.5% JSF showed higher levels, when compared to the control (Table 2). Dietary fibers are essential to maintain a good health and reduce the risk of various diseases, such as cardiovascular diseases and diabetes (Farvid et al., 2016). According to American Diabetes Association (2014), daily reference values (DRV) for dietary fibre range from 20 to 25 g. With the addition of 1.5% JSF, 100 g of this restructured ham would provide between 2.1% and 2.6% the fibre amount required for an adult per day, regarding daily values. Despite the significant amount, this restructured ham added with JSF can not be considered high in fibre since, according to Brasil (2012), to be rich in fibre, a solid product has to present 5 g fibre per 100 g food and, to be a fibre source, it must contain at least 2.5 g fibre per 100 g food.

The caloric value of the restructured ham with the replacement of 1% JSF did not differ from the control (Table 2). However, there was a reduction in the restructured ham with 0.5% JSF, regarding the increase in dietary fibre and in the caloric value for the restructured ham with 1.5% JSF. This increase is possibly due to the loss of some compounds during cooking.

The increase in JSF added to the formulation of the restructured hams favoured product weight loss (Table 2), coming to a loss of over 14% in restructured hams added with 1.5% JSF, except for the restructured ham added with 0.5% JSF, which was not statistically different from the control. The weight losses occur due to the formation of exudate during cooking, which is not desirable, since it impairs preservation of sensory attributes and process yield (Caldara et al., 2012).

Phenolic compounds, pH values and TBARs (Table 2) did not differ with storage time (P ≤ 0.05), but were statistically different among JSF concentrations.

A decrease in pH was observed with increasing JSF concentrations in the formulation, and formulations containing 1% and 1.5% JSF differed from the control (Table 2). The low pH of JSF can explain this difference. The significant decrease in pH with increasing JSF concentrations can explain the behaviour observed for weight loss in the treatments, once the addition of 1.5% JSF showed a higher mass acidification and, as pH decreases, it approaches the isoelectric point of meat proteins (pH 5.3), which lose water-holding capacity (Roque-Specht et al., 2009). For water activity (Aw), was no significant difference among the different restructured hams.

The content of phenolic compounds increased with the increase in the flour. The content in the restructured ham added with 1.5% JSF is almost three times higher than the control, also showing that processing did not destroy phenolic compounds (Table 2). Phenolic compounds play a significant role in preventing of various diseases, due to their antioxidant properties, having the potential to be used as an additive in the food industry, with possible health benefits.

The TBARs index was higher with the increase in JSF (Table 2), but that does not mean that hams with higher flour concentrations underwent oxidation since, according to Lee et al. (2012), other aldehydes, not coming from lipid degradation processes, may react with TBAR, particularly when the content of malonaldehyde is low, overestimating the extent of oxidation.

The colour coordinates L*, a* and b* did not differ with storage time (P ≤ 0.05), but were statistically different among JSF concentrations. The coordinate L* was the only one to present a significant difference in relation to JSF concentrations, showing how dark the restructured ham added with 1.5% JSF was, since the decrease in L* represents a lower brightness (Table 3).

Regarding objective texture, all parameters were significantly different (P < 0.05; Table 3). Stiffness increased with the addition of 0.5% flour, thus suggesting that the restructured ham prepared with the flour may have a higher binding force, due to water absorption by the flour, which contributes to the texture of the product, and significantly decreased when added with 1.5% flour, turning this restructured ham into a less firm product than the control, while the restructured ham added with 1.0% did not differ from the control.

There was decrease in cohesiveness values with the increase in JSF concentrations, except for the 0.5% flour. Therefore, it is possible to state that these products deform more easily. Adhesiveness behaved similarly to stiffness, increasing with the addition of 0.5% JSF, and decreasing with the addition of 1.5% JSF. Flexibility was only lower for the ham added with 1.5% JSF. Chewiness was lower than the control in hams added with 1.0 and 1.5% JSF (Table 3).

The lowest values observed for stiffness, cohesiveness, chewiness, adhesiveness and flexibility were in the restructured ham with 1.5% JSF. With the increase JSF there was a decrease in pH, resulting in the loss of water, which is the ingredient responsible for the formation of a bonding net that contributes to the texture of the product. Similar results were found in restructured hams added of yacon flour (Contado et al., 2015).

3.2 Sensory analysis

For all parameters, before informing the panellists that restructured hams added with JSF would possibly have higher antioxidant activity and dietary fibre contents, the highest scores were assigned to the restructured ham "control", and the lowest scores, to the ham added with the highest flour concentration (Table 4).

Restructured hams added with 0.5% and 1.0% JSF received scores from 6 to 7, which represents "like slightly" and "like moderately", except for the restructured ham added with 1.0% JSF, which received a score of 5.58 for appearance. In addition, the analysis of variance for overall aspect did not show a significant difference between the restructured ham "control" and those added with 0.5% and 1.0% JSF, after informing the panellists that they would possibly bring health benefits (Table 4).

Therefore, it was found that restructured hams with lower JSF concentrations had greater acceptance. The highest JSF concentrations resulted in the darkening of restructured hams, making them less attractive, but not harming their flavour.

Principal component analysis, associated to the evaluated restructured ham samples, was carried out for CATA (Figure 1).

It was observed that the characteristics: bright surface, pink colour, characteristic aroma of restructured hams, characteristic flavour of restructured hams, firm texture, soft texture and juicy texture, were assigned to the restructured ham "control" and that added with 0.5% JSF. On the other hand, undesired characteristics were mainly attributed to the restructured ham added with 1.5% JSF, possibly it happened due to this restructured hams are darker than the control, and restructured hams replaced with 1.0% and 1.5% JSF had lower pH and, as a consequence, greater water loss and thus lower juiciness and losses in texture parameters.

Table 3. Luminosity component L*, chromaticity indices a* and b*, and texture indices of the restructured hams.

	Restructured ham[1]				CV (%)
	0% (control)	0.5%	1.0%	1.5%	
L*	62.86 ± 2.34 a	57.04 ± 1.36 b	53.87 ± 2.29 c	48.96 ± 1.09 d	4.27
a*	4.80 ± 0.74	4.07 ± 0.53	4.39 ± 0.78	4.71 ± 0.44	4.50
b*	6.71 ± 0.74	6.70 ± 0.46	6.03 ± 0.08	6.38 ± 0.44	7.21
Stiffness (N)	28.34 ± 0.84 b	32.22 ± 0.35 a	25.69 ± 0.76 b	12.77 ± 0.26 c	15.95
Cohesiveness	0.68 ± 0.09 a	0.65 ± 0.07 a	0.50 ± 0.13 b	0.43 ± 0.16 b	13.95
Adhesiveness (N.mm)	0.13 ± 0.01 ab	0.17 ± 0.00 a	0.12 ± 0.02 ab	0.06 ± 0.00 c	2.67
Flexibility (mm)	5.18 ± 0.16 a	5.11 ± 0.13 a	4.97 ± 0.05 a	4.12 ± 0.10 b	7.15
Chewiness (N.mm)	99.73 ± 1.09a	113.57 ± 2.28 a	63.53 ± 0.93 b	23.47 ± 0.72 c	14.47

[1]0% (control): without the addition of jabuticaba skin flour (JSF); 0.5%: addition of 0.5% JSF; 1.0%: addition of 1.0% JSF and 1.5%: addition of 1.5% JSF. Data are the mean of three replicates ± standard deviation. Different letters in rows differ by the Tukey test ($P \leq 0.05$).

Table 4. Sensory acceptance test of restructured hams added with different percentages of jabuticaba skin flour (JSF).

JSF (%)[1]	Appearance[2]	Aroma[2]	Flavour[2]	Texture[2]	Overall aspect without information[3]	Overall aspect with information[4]
0.0 (control)	7.75 a	7.80 a	8.07 a	7.84 a	8.02 a	7.41 a
0.5	6.12 b	6.97 b	7.29 b	7.05 b	7.00 b	7.14 a
1.0	5.58 c	6.77 b	7.08 b	7.22 b	6.90 b	7.07 a
1.5	4.49 d	6.13 c	5.90 c	5.66 c	5.74 c	6.38 b
CV (%)	22.99	17.44	19.79	19.17	17.16	21.41

[1]0% (control): without the addition of jabuticaba skin flour (JSF); 0.5%: addition of 0.5% JSF; 1.0%: addition of 1.0% JSF and 1.5%: addition of 1.5% JSF. Different letters in columns differ by the Tukey test ($P \leq 0.05$). [2]1-9 point hedonic scale. [3]Overall aspect without information - the panellists were not informed that the addition of JSF would bring health benefits. [4]Overall aspect with information - the panellists were informed that the addition of JSF would add the restructured hams with antioxidant substances and dietary fibre, with possible health benefits.

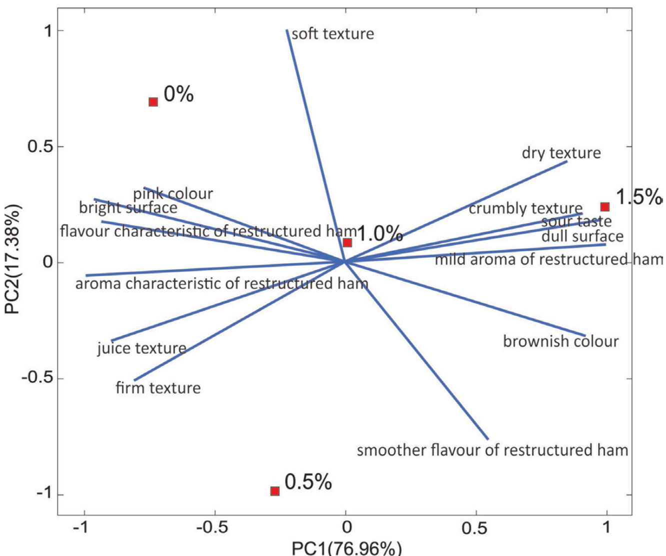

Figure 1. Principal component analysis (PCA) of the CATA – Check-All-That-Apply – test for restructured hams prepared with different percentages of jabuticaba skin flour (JSF). 0% (control): without the addition of jabuticaba skin flour (JSF); 0.5%: addition of 0.5% JSF; 1.0%: addition of 1.0% JSF and 1.5%: addition of 1.5% JSF.

4 Conclusion

It is concluded that it is possible to prepare and store restructured hams added with JSF e and that 0.5% of JSF concentration virtually no changes in the physicochemical properties, except for the increase of fiber, phenolic compounds and hardness and reduced brightness. Moreover, the restructured hams added with 0.5% of JSF may be well accepted, since the information that it has antioxidants and dietary fibre, which can bring benefits to consumers' health, is provided in the product label.

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