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Proceeding Paper

Development of Jams with Ancestral Seed Aggregates †

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Abstract: Small-scale food producers have been negatively impacted by the present pandemic and have been forced to use innovations with low-risk products as a means to increase sales. The object was to determine variations in the nutrient profile of peach jam with the introduction of amaranth or quinoa seeds, the latter having been rinsed beforehand to reduce saponin content. Three varieties of the jam were made, and these were subjected to a sensory evaluation by a panel of 30 untrained judges (consumers) and analysed to determine the variation in their composition as a result of the addition of the seeds. To the basic preparation, which consisted of peaches and sugar (PJ), 20% of quinoa seeds were added (QJ) at the bottling stage. To the third jam preparation, amaranth seeds were added in the same proportion (AJ). Official analytical techniques were used to determine their nutrient profile. The protein content increased from 0.23 g% (PJ) to 2.52 g% (QJ) and 3.38 g% (AJ). Total fat increased from 0.35 g% (PJ) to 0.74 g% (QJ) and 1.72 g% (AJ). Fibre increased from 2.13 g% (PJ) to 4.24 g% (QJ) and 2.86 g% (AJ). The incorporation of amaranth and quinoa improved protein profile, fibre and total fat intake and also resulted in a jam with a better nutrient profile, although there was only a slight reduction in carbohydrates, from 68 g% to 66 g%, after the seeds were added. Plum and apricot jam were also tested, and in all instances, the results were similar.

Keywords: amaranth; fruit jam; nutritional profile; vegetable protein; quinoa

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1. Introduction

The current COVID-19 pandemic led to a drop in sales in all sectors, especially affecting small food processors, which is why innovating in low-risk products allows them to expand their sales [1]. Small producers do not have adequate infrastructures to produce foods that could put the consumer's health at risk, such as highly acidic preserves, due to the possibility of the development of botulism [2]. For this reason, they are encouraged to produce low-risk foods, such as jams from different fruits. To be considered a jam, its consistency must be spreadable, have a soluble solids content of 65 °Brix, be free of skin, seeds or pits from the fruit, except those such as strawberries that cannot have their skin or seeds removed [3]. Their spreadability makes them very popular because they are eaten together with biscuits or bread at breakfast or snacks. One of the problems with these jams is their low nutritional value, as they only provide simple sugars and energy. Improving the nutrient profile by adding ancestral seeds not only increases the range of products offered by these small entrepreneurs but also improves the nutritional value of the jams, with the consequent impact on consumers' health [4].

The ancestral seeds chosen were (*Amaranthus caudatus*) and quinoa (*Chenopodium quinoa Willd.*), both with very good crop yields in Mendoza, Argentina, and especially in the northwest of the country. Amaranth was chosen for its protein content of 16 to 18 g% [5], with a complete amino acid profile, resulting in a protein of high biological value. Within its lipid fraction, it provides squalene, which is related to lowering cholesterol, according to a study published by Gonor in 2006 [6].

Quinoa (*Chenopodium quinoa Willd.*) [7] is an ancient crop that is ideal for populations suffering from protein malnutrition. Depending on the variety, its content varies from 13 to 21%, with a complete amino acid profile. According to FAO (2013) [7], it is a food that contributes to global food security. It has a dietary fibre content of around 12 g%, which reduces the digestibility of the grain, but provides satiety. It has a high vitamin E content, which acts as an antioxidant, protecting the fatty acids it provides [8], of which 50% correspond to polyunsaturated fatty acids (omega 6) and 25% to monounsaturated fatty acids (omega 9) [9].

The objective was therefore to determine the variation in the nutritional profile of a peach jam by adding amaranth seeds or quinoa seeds. This experiment was then repeated with plum and apricot jam.

2. Materials and Methods

Peach jam (PJ—base jam), peach jam with quinoa seeds (QJ—quinoa jam) and peach jam with amaranth seeds (AJ—amaranth jam) were made in triplicate. Plum jam, with and without seeds, and apricot jam, with and without seeds, were produced with the same characteristics.

2.1. Preparation Methods

The peach jam was made in triplicate. This was done on a pilot scale, using an open pan with permanent agitation. The peaches, previously washed, peeled and pitted, were ground to obtain the pulp, to which 300 mg of citric acid per kg was added to avoid oxidation. The ratio was 700 g of sugar per kg of pulp. The pulp and only 10% of the calculated sugar were placed in the pan and boiled with constant stirring. After approximately 30 min, when the pulp reached 35–40 °Brix, the rest of the sugar was added, reaching the final point of 65 °Brix after approximately 45 min. This results in a light-coloured, peach-scented jam. This was repeated using plums as a base and then apricots, with the only difference being that the latter was not peeled but was only pitted and ground.

When working with quinoa, the seed was first washed seven times with twice the volume of water until no more foam was formed. This removes all the saponins. If this operation is not carried out correctly, the seed takes on a bitter taste, which is transferred to the jam. Once the seed has been washed and drained, it is added in a proportion of 20% of the pulp when the rest of the sugar is added, which is when there are only a few minutes of cooking time left.

In the case of the amaranth seed, it was washed once, drained and added in the same proportion and at the same time as detailed for quinoa.

The same steps were followed for plum seed jam or apricot seed jam.

2.2. Laboratory Analysis

The following methods were used to determine the nutritional composition of the different jams, with and without seeds [10]:

Humidity: Method of A.O.A.C 950.46 B. Indirect method by drying in an oven at 100–105 °C, until constant weight is achieved.

Total fat: Direct method by extraction with ethyl ether (crude fat), Soxhlet gravimetric method (A.O.A.C. 960.39, 1990) was used.

Fibres: Acid alkaline attack (AOAC, 15th edition 1990) was used.

Crude protein: Kjeldahl method, (A.O.A.C. 928.08, 1990), determining nitrogen, using 6.25 as a protein conversion factor.

Ashes: Direct Method (A.O.A.C. 923.03, 1990): by incineration in muffle (at 500 ± 10 °C), until constant ash weight.

Carbohydrates: determined by difference, by the following formula:

100 − (weight in grams [protein + fat + water + ash + fibres]), in 100 g of food.

Energy value: by calculation

Energy value (kcal) = By calculation. The conversion is 2000 kcal = 8400 kJ.

Statistical analysis. The Kolmogorov–Smirnova test was applied to check the assumption of normality of the residuals, and the Levene's test for homoscedasticity of variances was applied to check the homoscedasticity of the residuals. To compare the means of nutrients between the different jams, an ANOVA test was applied, and for post hoc analysis, Tukey's test was used. The analysis was carried out with the SPSS® statistical package.

2.3. Sensory Analysis

In order to assess the acceptability of the jams, an acceptance test was carried out with 30 untrained judges.

3. Results

3.1. Peach Marmalade with and without Added Seeds

Table 1 shows the nutritional composition of the peach jam (PJ) compared to the amaranth seed jam (AJ) and the quinoa jam (QJ).

Table 1. Peach Jam composition.

	PJ	AJ	QJ
Protein g%	0.23 ± 0.02	3.38 ± 0.03	2.74 ± 0.02
Carbohydrates	68.00 ± 0.19	66.36 ± 0.20	66.27 ± 0.32
Total Fats g%	0.35 ± 0.02	1.72 ± 0.03	0.74 ± 0.03
Saturadted fats g%	0.02 ± 0.01	0.26 ± 0.02	0.07 ± 0.02
Ashes g%	0.65 ± 0.02	0.64 ± 0.04	0.97 ± 0.02
Humidity g%	28.64 ± 0.22	25.03 ± 0.15	28.64 ± 0.22
Dietary fibre g%	2.13 ± 0.09	2.86 ± 0.03	4.24 ± 0.09
Sodium mg%	17 ± 1	14 ± 3.61	17 ± 1
Energy value kcal	276 ± 0.82	294 ± 0.57	283 ± 1.24
Energy value kJ	1159 ± 3.43	1237 ± 2.40	1187 ± 5.19

Protein content increased from 0.23 g% (PJ) to 2.52 g% (QJ) and 3.38 g% (AJ). Total fat increased from 0.35 g% (PJ) to 0.74 g% (QJ) and 1.72 g% (AJ). Fibre increased from 2.13 g% (PJ) to 4.24 g% (QJ) and 2.86 g% (AJ). With the incorporation of amaranth or quinoa, the contribution of protein, fibre and total fat was improved, achieving a jam with a better nutritional profile, the decrease in carbohydrates not being significant, going from 68 g% to 66 g%, due to the incorporation of the seeds.

Applying statistics to the values obtained, it turns out that the analysis of the assumptions of normality and homogeneity of the residues is fulfilled with a p-value greater than 0.05. For ANOVA tests comparing peach jam (PJ), with added amaranth (AJ) and with added quinoa (QJ), statistically significant differences were found in the following nutrients ($p < 0.001$): protein, carbohydrates, dietary fibre, total fat and energy content.

3.2. Plum Jam with and without Added Seeds

Table 2 shows the nutritional composition of the plum jam (PlJ) compared to the jam with amaranth seeds (APlJ) and the jam with quinoa (QPlJ).

Again, the highest protein and lipid values were obtained with the addition of amaranth seeds, together with lower carbohydrate content and intermediate fibre content. The highest fibre content is obtained in the quinoa seed jam.

For the ANOVA tests comparing plum jam (PlJ), with the addition of amaranth (APlJ) and with the addition of quinoa (QPlJ), statistically significant differences were found in the following nutrients ($p < 0.001$): protein, carbohydrates, dietary fibre, total fat and energy content.

Table 2. Plum Jam composition.

	PlJ	APlJ	QPlJ
Protein g%	0.38 ± 0.03	3.50 ± 0.02	2.86 ± 0.02
Carbohydrates	65.33 ± 0.31	64.22 ± 0.15	64.14 ± 0.31
Total Fats g%	0.33 ± 0.02	1.70 ± 0.02	0.73 ± 0.04
Saturadted fats g%	0.03 ± 0.01	0.26 ± 0.02	0.08 ± 0.02
Ashes g%	0.51 ± 0.06	0.52 ± 0.03	0.85 ± 0.02
Humidity g%	29.28 ± 0.33	25.56 ± 0.04	25.55 ± 0.30
Dietary fibre g%	4.17 ± 0.14	4.50 ± 0.06	5.87 ± 0.01
Sodium mg%	15.33 ± 2.08	11 ± 2	15 ± 2
Energy value kcal	266 ± 1.41	286 ± 0.37	275 ± 1.35
Energy value kJ	1116 ± 5.93	1202 ± 1.55	1153 ± 5.68

3.3. Apricot Jam with and without Added Seeds

Table 3 shows the nutritional composition of the apricot jam (ApJ) compared to the amaranth seed jam (AApJ) and the quinoa jam (QApJ).

Table 3. Apricot Jam composition.

	ApJ	AApJ	QApJ
Protein g%	0.20 ± 0.03	3.36 ± 0.03	2.84 ± 0.10
Carbohydrates	66.50 ± 1.15	65.16 ± 0.13	64.59 ± 0.14
Total Fats g%	0.20 ± 0.03	1.60 ± 0.04	0.73 ± 0.02
Saturadted fats g%	0.02 ± 0.01	0.26 ± 0.02	0.07 ± 0.02
Ashes g%	0.63 ± 0.03	0.61 ± 0.01	0.88 ± 0.04
Humidity g%	29.71 ± 1.23	25.90 ± 0.08	25.43 ± 0.27
Dietary fibre g%	2.76 ± 0.06	3.37 ± 0.01	5.53 ± 0.09
Sodium mg%	7 ± 2	11 ± 1	16 ± 2
Energy value kcal	269 ± 4.47	288 ± 0.25	276 ± 0.68
Energy value kJ	1128 ± 18.77	1212 ± 1.06	1160 ± 2.86

The observations for peach and plum are repeated.

4. Discussion

The addition of amaranth and quinoa improved the protein content of high biological value provided by the seeds, considering that the jams do not provide protein or lipids. Fats are also provided by quinoa and amaranth, with the advantages of the healthy fatty acid profile of these seeds. With regard to fibre, fibre consumption increases, with all the benefits that the intake of this nutrient brings.

5. Conclusions

The addition of amaranth and quinoa seeds to different jams improves their nutritional profile in all cases. It is a simple practice to apply in small producers, increasing the supply of healthier foods and revaluing ancestral seeds.

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