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RESEARCH PAPER

Snack production from apple (*Malus domestica* B.) and tomatoes (*Lycopersicon escullentum* Mill) agglomerates by using different thickening agents

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Abstract

N.E. Loyola López, L. Calquin Rivera, C.A. Acuña Carrasco, and M.A. Arriola Herrera. 2022. Snack production from apple (*Malus domestica* B.) and tomatoes (*Lycopersicon escullentum* Mill) agglomerates by using different thickening agents. Int. J. Agric. Nat. Resour. 51-61. A snack is a type of food that is of great relevance in the daily diet of persons; it has specific characteristics, such as a crispy texture and a low water content, such as fruits and vegetables. Snacks are easy to handle, carry and store; in particular, they can be immediately consumed anywhere. Therefore, the feasibility of snack production from apples and tomatoes was evaluated. The following thickening agents were added to each treatment: apples, tomatoes and guar gum (T_1); apples, tomatoes and carrageenan (T_2); and apples, tomatoes and honey (T_3). The raw materials were apples and tomatoes, and they underwent a dehydration process with forced air; then, the different snacks were subjected to physical-chemical evaluations, such as pH, dietary fiber, soluble solids and acidity. A sensorial evaluation was carried out for each treatment by trained panelists who considered the intensity of the attributes, such as color, texture, smell and flavor, as well as the acceptability of the final product. The hypothesis was partially supported under the assay considerations. The best result was achieved when honey was used as a thickening agent (T_3); the snacks presented a crispy texture. The products produced from treatment T_3 had a better evaluation of their sensorial and acceptability characteristics.

Keywords: Carrageenan, crispy, guar gum, honey.

Introduction

A snack is a type of food that is relevant in the daily life and diet of persons. A snack has specific characteristics, such as a low water content among fruits and vegetables. They have a crispy texture and a good flavor for consumers. They preserve the bioactive components of vegetables, which are of great benefit to the health of consumers. They are easy to handle, transport, store and consume anywhere (Vio del Río, 2012).

A total of US$ 3.667 million was obtained from the snack market in Chile in 2015. The increase was 16.3% in comparison to the sales from 2010,

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where US$ 3.154 million were obtained. There was an increase in the tons sold between 2010 and 2015 (AB CHILE, 2016).

The increasing consumption of this type of product, especially fruits and vegetables, is because people are more conscious of what they are consuming today. People are experiencing significant health problems in Chile today because they are not eating a healthy diet. For example, in Chile, one out of ten persons is overweight, and five out of ten children are overweight (Ministerio de Salud de Chile- MINSAL, 2015). Meanwhile, increased consumption of fruits and vegetables is an indicator of good dietary habits leading to good health. For example, phytochemicals, which are present in vegetables, are very important in the diet and thus promoting good eating habits of healthy food can decrease diseases and reduce the rates of chronic, nontransmissible diseases (Sepúlveda et al., 2011).

The following study was proposed as a way to alleviate the problems mentioned above. A snack based on apple and tomato agglomerates was made with different thickening agents to obtain a product with nutritional properties and increased sensorial attributes. The following hypothesis was put forward: it is possible to create snacks by using tomato (*Lycopersicon esculentum* P. Mill) and apple agglomerates (*Malus domestica* B.) with different thickening agents, such as guar gum, carrageenan and honey, that have good nutritional and sensorial properties. The following study was conducted to test this hypothesis.

General objective: Evaluate guar gum, carrageenan and honey as thickening agents for preparing snacks from tomatoes and apple agglomerates.

Specific objectives:

Evaluate the sensorial attributes of the snacks, such as color, smell, flavor, texture and acceptability.

Evaluate the nutritional parameters of the snacks, such as dietary fiber, total sugar and vitamin C.

Evaluate the chemical parameters of the snacks, such as pH, acidity, and soluble solids.

Materials And Methods

The raw materials, tomatoes and apples, were transported in coolers, one for each specimen. An inner protection of alveolar film was placed inside each cooler before transporting the produce to the place where the snacks were made, the Universidad Católica del Maule, Campus San Isidro, camino a Los Niches, km 6, Curico; 35° 01’42.0” S 71°11´39.8” W (Centro Nacional de Estudios Espaciales map data @ 2018 Google).

The apples cv. Fuji, used for snack preparation, were purchased from Talcarehue, Rincon Ltd., Community of San Fernando, Libertador Bernardo O´Higgins Region; 34°37´50.8” S 70°53´18.7” W.

The tomatoes were bought in La Ramada at Carlos Morales & Sons Ltd., Agrocommercial Industry, San Fernando Community, Libertador Bernardo O´Higgins Region; 34°58´22.6” S 71°01´46.6” W (Centro Nacional de Estudios Espaciales, map data @ 20018 Google).

Snack preparation

First, the raw materials for snack preparation, apple cv. Fuji, and tomatoes cv. Maria Italia, together with the thickening agent used in treatment T_3 (the honey was obtained from the beekeeper of the Puente Negro Sector), were collected. Guar gum for T_1 was collected from Quimatic S.A. Enterprise. This enterprise deals with different food industries, such as dairy, meat, beverages, and snacks. The carrageenan was obtained from Gelymar S.A., an enterprise dealing with natural products.

The first step in the preparation of the snacks was the selection of apples and tomatoes that were in optimal conditions to be used, free from

foreign objects, vegetative materials, dust, and so forth, and those presenting an adequate aspect to be used, such as a good size, firmness, and soluble solids.

Apples

The best apple cv. Fuji, having no signs of external damage and in an optimal condition to be used with pressure (range) 15 to 18 pounds and soluble solids over 13 °Brix, were selected (Hernández et al., 2010).

The skin and the core were manually removed, leaving only the flesh of the apple, which was then cut into slices with a thickness no greater than 5 mm. After the apple slices were ready, they were placed in a solution of 3 L of water, metabisulfite of sodium (300 ppm) and citric acid for 10 minutes. The metabisulfite of sodium acts as an antimicrobial agent, delaying microorganism growth and also acts as an anti-browning agent, preventing color deterioration and oxidation and improving the retention of some vitamins. Citric acid is necessary for controlling the fruit acidity and for facilitating the action of preservatives (Maris, 2004).

The apple slices were dehydrated at 65 °C for ten hours (FAO-PRODAR, 2014). A forced air stove (Memmert UFB 500) and a food dehydrator (Recco RD. KYS326B) were used for this purpose. The dehydrated slices were then ground into a powder, and agglomerates with the dehydrated tomatoes were formed. A Minipimer Black and Decker SB400 was used for grinding.

Tomatoes

Tomatoes that did not have any visible external damage and that presented optimal quality conditions (healthy, mature, over 90% red color; desirable for consumption and of a firm consistency) were selected (Kader, 2002).

Gentle washing was carried out to remove any external elements that might have been present on the tomatoes. A chloride solution (30 ppm) was used for 15 seconds (Ministerio de Salud de Chile, 2013). The peduncle was eliminated and then to tomatoes were cut into slices and then dehydrated at 65 °C to avoid nonenzymatic oxidation and browning; they were left there for 10 hours (Urfalino, 2011). Then, the majority of seeds present in the dehydrated slices were eliminated. A forced air stove (Memmert UFB500) and a food dehydrator (Recco RD-KYS326B) were used. The dehydrated tomato slices were ground into a powder to form an agglomerate with the dehydrated apple segments. A Minipimer Black and Decker SB400 was used for grinding.

The two fruits were processed separately because apples formed the bulk of the material in the snacks. After that, the final mixtures were prepared. Each treatment was allowed to stand for one hour, then they were molded and dried at 40 °C in the case of T_1 and T_2, and for T_3, they were refrigerated at 5 °C, and finally packed. Aluminum foil was used for packing the snacks, and then they were put in transparent polyethylene bags. They were allowed to stand for 10 days. The analyses and assessments for the nutritional, chemical, sensorial, and acceptability aspects were then carried out.

Three different treatments were applied:

Treatment (T_1): 0.5 g of guar gum dissolved in 10 mL of cold water was added to each 14 g of apple and 6 g of tomato to form the agglomerates. It was allowed to stand for approximately one hour; then, it was molded, dried at 40 °C and finally packed.

Treatment (T_2): One gram carrageenan previously dissolved in 10 mL of hot water was added to each 14 g of apple and 6 g of tomato to form the agglomerate. It was allowed to stand for approximately one hour; then it was molded, dried at 40 °C and finally packed.

Treatment (T_3): 10 g of honey for each 14 g of apple and 6 g of tomato were placed in the containers

and then melted in boiling water to transition from a "grainy" state to a semiliquid state, facilitating the formation of the agglomerates. Then, the snacks were refrigerated for ten minutes at 5 °C, and finally packed.

Once the different treatments were carried out, the snacks were assessed and analyzed ten days after preparation. Three repetitions of each treatment were performed to obtain a correct estimation of the results.

Sensorial Evaluation and Acceptability:

The evaluation of the sensorial attributes was carried out by using sensory evaluation sheets numbered from 0 to 13 as described in the references. Thirteen trained panelists each received a sheet and then they evaluated the different characteristics of the product, such as color, smell, texture and flavor. They also evaluated the acceptability of the product by using the structured forms, giving a score from 1 to 9 (Stone & Sidel, 1993).

Chemical Parameter Evaluation

pH: pH was determined by using the official method AOAC 981. 12 (AOAC, 1990); a pH-meter Hanna H1 8424 was used.

Soluble Solids: Measurements were carried out by using refractometers Milwaukee MA 871 and ATAGO N-3e-°Brix 58-90, according to the official method 9312,12 AOAC (1990), and the results were expressed in °Brix.

Total acidity: According to the official method AOAC 942.15: acidity (valuable) in fruit products (AOAC, 1990).

Nutritional Assessment: Dietary fiber was determined by using the gravimetric method 962.09 (Association of Official Analytical Chemists – AOAC, 1990).

Vitamin C: Vitamin C was determined by using the quantitative method AOAC 967.21, titratable official analysis 2.6 – dicloroindofenol. This method is based on the reduction of a sodic salt solution of 2,6-diclorofenolindofenol by ascorbic acid. The final results is determined by the pink color in the solution because of the presence of 2.6 – diclorofenolindofenol without reduction in acidic media (Association of Official Analytical Chemists, 2000).

Total Sugars: Sugars were determined by using the Molisch Test. This test is based on the hydrolyzing action and dehydration of sulfuric acid concentrated in carbohydrates. In this test, the strong acid catalyzes the hydrolysis of sugars present in the sample and the dehydration of monosaccharides that results in the formation of furfurals. These furfurals condense with the alpha-naphthol of the Molisch reagent, forming a violet ring, indicating the presence of carbohydrates (Rodríguez, 1987).

Experimental Design: The experimental design unit corresponded to 20 g of snack for each of the formulations that were carried out (Table 1), and the effects of the three treatments were evaluated by repeating them three times each. The experimental design was a completely random model (D.C. A), where the three treatments were assessed uniformly to avoid influencing the results.

Statistical Analysis: The data analysis was performed through a variability analysis (ANDEVA) if the normality and homogeneity assumptions were confirmed. The Tukey test was used in cases where significant differences were obtained, having a reliability level of significance at 5% probability ($p<0.05$).

The collected data did not meet the assumptions of normality and homogeneity, so they were analyzed with a nonparametric Kruskal–Wallis test, with a reliability level of significance at 5% probability ($p < 0.05$). The data collected for each of the analyses were entered into the statistical program XLSTAT, 2014 version.

Table 1. Treatments used for snack production.

Treatments	Used products	Characteristics
T_1	Guar gum	For each 20 g of dehydrated food, 14 g of apple & 6 g of tomato, 0.5 g of guar gum was added, dissolved in 10 mL of cold water.
T_2	Carrageenan	For each 20 g of dehydrated food, 14 g of apple & 6 g of tomato, 1 g of carrageenan was added, dissolved in 10 mL of hot water.
T_3	Honey	For each 20 g of dehydrated food, 14 g of apple & 6 g of tomato, 10 g of honey was added.

Results And Discussion

Chemical and nutritional parameter characterization of the raw materials

To characterize the raw materials, soluble solids, pH, total acidity and vitamin C were determined.

For the tomatoes cv. Maria Italia, the average results of the analysis were pH, 4.25; soluble solids, 4.4 °Brix; total acidity, 0.24%; and vitamin C, 19.5 mg/100 g, which were comparable to the ranges established by Nuez (1995): soluble solids, 1.5°Brix - 4.5 °Brix; total acidity, 014%-0.2%. (Escalona et al., 2009) stated that the pH is less than 4.5. In the case of vitamin C, the obtained result was over the average stated by Toor and Savage (2005), 16.9 mg 100 g^{-1} – 17.8 mg 100 g^{-1}.

In the case of apples cv. Fuji, the obtained results were as follows: soluble solids, 15.73 °Brix; total acidity, 0.29%; pH, 3.40; and vitamin C, 8.1 mg/100 g. These results were comparable to those given by some authors, such as Arthey and Ashurt (1996), soluble solids over 13 °Brix, pH between 2.8 and 3.3, and acidity between 0.2% and 0.3%. In the case of vitamin C, the obtained results were over the average stated by Schmidt et al. (1992) as vitamin C, 5.6 mg 100 g^{-1}.

Characterization of the chemical and nutritional parameters of the finished product

Once the snacks were made by undergoing the different treatments, chemical and nutritional analyses were carried out. The results obtained are shown in Table 2, corresponding to each treatment (T_1, T_2, T_3).

The values correspond to the average ± standard deviation. Different letters in the columns indicate significant differences at 5% probability ($p<0.05$).

pH

Snacks made with treatment T_1 had the highest pH level, with a value of 4.20, while those with treatment T_3 had the lowest level, with a value of 4.12 (Table 2). When the pH of the treatments was

Table 2. pH content, soluble solids, dietary fiber and acidity of the finished product.

Characteristics	pH	Soluble solids (°Brix)	Dietary fiber (%)	Total acidity (%)
T_1	4.20±0.17 a	10.2±0.40 b	5.24±0.23 a	0.26±0.015 a
T_2	4.18±0.04 a	14.4±0.52 b	5.37±0.23 a	0.27±0.018 a
T_3	4.12±0.03 a	32.86±3.47 a	5.15±0.05 a	0.27±0.05 a

compared with products of similar characteristics, it was possible to observe that the averages for each treatment were similar. A pH between 4.09 and 4.34, according to Moreno et al. (2014), was obtained in an assessment performed on the quality of the dehydrated tomatoes, while in the case of an apple snack, the pH was 3.6 according to Lavelli (2009).

It should be noted that the different thickening agents employed for each treatment, guar gum, carrageenan and honey, presented different pH values; for example, honey showed a pH of 3.9, according to Arvanitoyannis et al. (2005), which was related to the lower average (pH 4.12) obtained in the different treatments. Guar gum presented a pH between 5.5 and 6.5 according to the information given by Quimatic, and for carrageenan it was between 7.0 and 10.0, according to the information provided by Gelymar.

Alarcón (2003) established that pH could be an important factor for the correct stability and function of carrageenan (T_2), since in order for this hydracolloid to accomplish its thickening function, the pH must be closer to 9, and at 3-4 pH degradation will occur, losing viscosity, and not performing its thickening function. This occurred in treatment T_2 where carrageenan was used and an apple and tomato agglomerate was not formed.

Soluble Solids

Snacks made using treatment T_3 had the highest solids level among the treatments, reaching a value of 32.86 °Brix (Table 2). Treatments T_1 and T_2 were significantly different from treatment T_3, as shown in Table 2, and this difference was mainly due to the use of honey (82°Brix) as a thickening agent in the formulation of treatment T_3. Honey has the capacity of sweetening foods due to the presence of monosaccharide fructose and glucose as its main components (60 °Brix – 85°Brix) (Pérez, 2007). This differed from treatments T_1 and T_2, where the thickening agents that were used, guar gum and carrageenan, respectively, did not add any sugars.

Dietary fiber

The highest value of dietary fiber in the snacks was obtained with treatment T_2, with a value of 5.37%, whereas by using treatment T_3, only a minor percentage of dietary fiber was found, with a value of 5.15% (Table 2). According to previous investigations performed with apple snacks cv. Fuji, a nutritional analysis showed that the percentage of dietary fiber present was 19.4% in fresh apples and 24% in apple snacks (Sepúlveda et al., 2011). These are much higher values compared to the averages obtained in the different treatments, where the highest average obtained was 5.37%. The difference is probably due to the addition of tomatoes in this study. This influenced the percentage of dietary fiber present in the final snacks. Moreover, (Sepúlveda et al., 2011) stated that in apple snacks, the skin should be included because it has a higher proportion of dietary fiber than the pulp, which was confirmed by Leontowicz et al. (2002). We did not include the skin in our snacks.

Total acidity

The highest value of total acidity was obtained from the snacks made with treatment T_2, with a value of 0.27%, while the lowest value was found in snacks made with treatment T_1, with a value of 0.26% of total acidity (Table 2). No significant differences were found among the different treatments in terms of acidity. The obtained results were very similar to those of the raw materials used for this investigation. The tomatoes had a 0.24% acidity, and according to bibliographical information, tomatoes have an acidity between 0.14% and 0.2% (Nuez, 1995). The apples had a 0.29% acidity, and according to the bibliographical information stated by

Arthey and Ashurt (1996), apples have an acidity between 0.2% and 0.3%.

Vitamin C

Owing to the snacks being dehydrated products, it was not possible to perform a quantitative analysis of the quantity of ascorbic acid (vitamin C) that was present in each treatment; a qualitative analysis was performed instead. Different chemical reactions allowed for the determination of the presence or absence of vitamin C by means of an objective observation of the different treatments. The results obtained showed that there was vitamin C in the snacks from all three treatments. By performing a qualitative classification, snacks using treatment T_3 presented a lighter color in relation to the three treatments, mainly due to the honey content and the quantity of vitamin C (0.5 mg 100 g^{-1}). According to Graham (1992), such an amount is enough to produce a difference between treatments T_1 and T_2, which had a similar color and a darker color in comparison to treatment T_3, respectively.

Total Sugar

Due to the snacks being dehydrated products, it was not possible to carry out a quantitative analysis of the total amount of sugar present in each of the treatments; for this reason, a qualitative analysis was performed, which allowed for determining the presence or absence of total sugar through an objective observation of the different treatments by using the Molisch test. In all three treatments, the obtained results showed that there was a predominance of carbohydrates. A change in color was formed in the samples from blue to violet, and later on, the formation of a violet ring, as indicated in the Molisch test (Rodríguez, 1987). The treatment that showed the most visible ring was treatment T_3, where honey was used as a thickening agent, including monosaccharides fructose and glucose as its main components (60%-85%) (Pérez, 2007).

Sensorial Attribute Analysis

The results obtained in the corresponding study are presented as the average ± standard deviation. Different letters in the column show significant differences at 5% probability ($p<0.05$).

Smell

The snacks made with treatments T_1 and T_2 had a very similar assessment: 8.06 and 7.39, respectively, for the smell intensity of the final product. However, those using treatment T_3 had a value of 10.9, which was the highest value among the three treatments (Table 3). The difference between treatments T_1 and T_2 and treatment T_3, as can be observed in Table 3, was mainly due to the presence of honey, a thickening agent used in the formulation of treatment T_3. The most important characteristics of this type of product are its smell, flavor and color (Graham, 1992).

Table 3. Sensorial assessment of the finished product.

Sensorial attributes	Smell (0–13 cm)	Texture (0–13 cm)	Color (0–13 cm)	Flavor (0–13 cm)
T_1	8.06±0.52 b	7.58± 0.50 a	3.23±0.69 c	8.01±0.77 b
T_2	7.39±1.22 b	8.04±1.26 a	4.42±0.67 b	7.00±1.03 b
T_3	10.09±1.39 a	3.83±1.13	7.61±0.80 a	11.54±1.60 a

The honey smell in T_3 was immediately identified by the panelists. In the assessments of T_1 and T_2, the smell was mainly attributed to tomatoes, a raw material that was present at a lesser percentage than apples.

Color

The snacks obtained with treatments T_1 and T_2 presented a very similar assessment: 7.58 and 8.04, respectively, in the color intensity of the finished product. Those using treatment T_3 presented an average of 3.83, which was the lowest value of the three treatments (Table 3). The difference between treatments T_1 and T_2 and treatment T_3, as seen in Table 3, was mainly due to the changes during the rehydrating process and subsequent drying process applied treatments T_1 and T_2; this produced a change in color, perceived as a darker color compared to the snacks from treatment T_3, which presented a lighter color and was similar to the color seen immediately after the dehydration process of the raw materials. The quality indices of the products showed very variable changes in relation to the fresh product, such as texture and color. The subsequent drying process allowed us to observe that this was one of the main factors that influenced the quality of the rehydrated product (Lewicki, 1998).

Texture

Those snacks using treatments T_1 and T_2 had a similar assessment: 3.23 and 4.42, respectively, in the intensity of the texture of the final product, while those using treatment T_3 presented an average of 7.61, which was the highest value of the three treatments (Table 3). The difference obtained among the snacks with T_1 and T_2 and those obtained with treatment T_3, as seen in Table 3, was mainly due to the texture that guar gum and carrageenan produced. They were evaluated as having a softer and gelatinous texture than treatment T_3, which was assessed as having a crispier intensity, an important characteristic for the definition of a snack.

Flavor

Snacks using treatments T_1 and T_2 had a very similar assessment: 8.01 and 7.00, respectively, in the flavor intensity of the final product, while those using treatment T_3 showed an average of 11.54, which was the highest value of the three treatments (Table 3). While the snacks using treatment T_3 had a higher evaluation of the flavor intensity, as seen in Table 3, the snacks obtained from the three treatments were perceived and assessed with values closer to a sweet intensity, which was mainly due to the presence of the apples cv. Fuji, and especially in treatment T_3, where honey was used as a thickening agent.

Acceptability Assessment

The values correspond to the average $\pm$ standard error. Different letters in the columns show significant differences at 5% probability ($p<0.05$).

This assessment was based on the panelists´ opinions in relation to the acceptability degree that this product presented; the score was 1 to 9 on a structured form where 1 was used for an unacceptable product, and 9 was used for an excellent product.

The snacks from treatment T_3 were best accepted by the panelists; the average value was 7.7, and according to the evaluation degree, it was con-

Table 4. Acceptability of the finished product.

Treatments	Acceptability
T_1	5.61$\pm$0.65 b
T_2	5.92$\pm$0.64 b
T_3	7.69$\pm$075 a

sidered an acceptable to a good product (range 7 to 8), while snacks with treatment T_1 were given the lowest evaluations by the panelists, with an average value of 5.6. This product was assessed as having an indifferent acceptability (Table 4).

Conclusions

The hypothesis put forward for this research was partially achieved, mainly when honey was used as a thickening agent (T_3), presenting the proper characteristics of snacks. A crispy texture was highlighted.

In the nutritional assessment with the dietary fiber content, there were no significant differences among the treatments. The presence of vitamin C in the snacks showed a lighter coloration in treatment T_3 because honey was used as a thickening agent, and it contains vitamin C (0.5 mg 100 g^{-1}), which did not occur in the case of guar gum (T_1) and carrageenan (T_2).

In the case of total sugar, there was the presence of carbohydrates in all three treatments. Those snacks with treatment T_3 presented a ring of visible color because honey was used as a thickening agent.

There were no significant differences in the pH level or titratable acidity among the different treatments. Significant differences were found for soluble solids. In the case of soluble solids, significant differences were observed between T_3 and the other two formulations; this was mainly due to the thickening agent used in the formulation of treatment T_3, which corresponded to the use of honey, which has a high level of sugar.

There was a significant difference in all of the assessed attributes (color, texture, smell and flavor) in the sensorial assessment. This was mainly seen between T_3 and the other two treatments. In the acceptability assessment, the snacks made with T_3, containing apple, tomatoes and honey, were preferred by the panelists. The average assessment was 7.7, while treatment T_1 received a low acceptability evaluation by some of the panelists; its average assessment was 5.6.

Resumen

N.E. Loyola López, L. Calquin Rivera, C.A. Acuña Carrasco, y M.A. Arriola Herrera. 2022. Elaboración de snack a partir de aglomerados de manzana (*Malus domestica* B.) y tomate (*Lycopersicon esculentum* Mill.) con diferentes agentes espesantes. Int. J. Agric. Nat. Resour. 51-61. El snack es un tipo de alimento que día a día toma mayor relevancia en la vida y dieta de las personas, cuenta con características específicas, como, por ejemplo, contiene una baja cantidad de agua y una textura crocante en el caso de las frutas u hortalizas. Snack es un tipo de alimento de fácil manejo, ya sea para transportar o almacenar y sobre todo permite que su consumo sea rápido e inmediato. Es por lo anterior que se evaluó la factibilidad de realizar un snack, elaborado sobre la base de manzana y tomate, con diferentes agentes espesantes en cada tratamiento, utilizando las siguientes formulaciones: manzana, tomate y goma guar (T_1); manzana, tomate y carragenina (T_2); manzana, tomate y miel (T_3). Las materias primas utilizadas manzana y tomate, se llevaron a un proceso de deshidratación con aire caliente forzado, para eliminar gran parte del contenido de agua presente en cada especie. Posteriormente los diferentes snacks elaborados, se llevaron a evaluaciones físicos-químicos,

tales como; fibra dietética, pH, sólidos solubles y acidez. Se realizó una evaluación sensorial a cada tratamiento, por panelistas entrenados quienes percibieron la intensidad de los atributos; color, textura, aroma y sabor, como también la aceptabilidad del producto obtenido. La hipótesis se cumplió parcialmente, según las condiciones del ensayo. Los resultados donde se utilizó miel como agente espesante (T_3), presentó una textura crocante. Los productos elaborados con el tratamiento T_3 tuvieron una mejor evaluación de los atributos sensoriales y de aceptabilidad.

Palabras clave: Carragenina, crocante, goma guar, miel.

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