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Research Article

Formulation and Characterization of Energy Bars with Nutritional Value Using Different Concentrations of Wheat Flour and Amaranth Flour

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Abstract

The objective of this project was to formulate and characterize energy bars, which were made at different concentrations of wheat and amaranth flour, as well as to evaluate the physicochemical effect of each of the concentrations carried out. Five different types of formulations were obtained, which were mixtures of wheat flour (100, 75, 50, 25 and 0%) and amaranth (0, 25, 50, 75 and 100%) at different concentrations. The ingredients were mixed manually until obtaining a homogeneous paste, then they were baked at a temperature of 180°C for 40 min. The physicochemical characterization of the energy bars was carried out by determining water activity, humidity, color and texture. Water activity values of 0.59 to 0.75, respectively, and humidity values of 81.34 to 89.04% were obtained, which vary according to the flour concentrations used. In the texture analysis, high values of hardness and gumminess (356.61 N and 350.02 N) were obtained in the energy bars made with 100% amaranth flour. The data indicated that formulation 3 (50:50) turned out to be appropriate to standardize the process of making energy bars based on wheat and amaranth flour with a high nutritional value.

Keywords: Energy Bars; Wheat Flour; Amaranth Flour; Color; Texture; Hardness

Introduction

Currently in the food industry there is a great demand from the consumer to have healthy and quickly consumed products within reach, due to the speed of life today and which carries the risk of various diseases [1]. It is in this context that energy bars play a fundamental role due to their high energy content, generating satiety, thus avoiding the consumption of other non-nutritious foods [2]. It should be noted that the development of new trends in food has meant that many of the traditional food formulations are changing regularly. Energy bars, being a baking product, have wheat flour as their main ingredient. However, when looking for a solution to these consumer demands, there are non-conventional sources of flour, for example, cactus, chickpea, coconut and cassava, in this case amaranth flour is a promising example, this is a pseudo cereal with prominent nutritional characteristics [3], this grain has also been a fundamental part of the ancestral diet, since ancient civilizations, for example, the Mayans and Aztecs, included it in their diet [4]. Mexico is a country rich in agricultural resources, which allows formulations to be designed according to the tastes or needs of the population. And one of the intrinsic aspects of this type of product is that they are accompanied by other nuts such as almonds and raisins. As well as legumes such as peanuts. Each of these elements has exceptional properties, for example, almonds have the ability to reduce low-density cholesterol, they are a source of several minerals and vitamins [5]. In the case of raisins, being a fruit that has previously gone through a drying process, it has the advantage that most of its nutrients are concentrated, so they are a source of natural sugars such as fructose and glucose, but in addition to This, due to the high content of insoluble fiber, slows down digestion, therefore, its glycemic index is low. In the context of legumes such as peanuts, they contain omega 3, polyunsaturated oil, which provides benefits to the cardiovascular system. This is just to mention some of the ingredients and their benefits [6].

An important point is that, when innovating in the development of a food, it must be guaranteed that the unconventional element and the base ingredients complement each other to give rise to good flavor, texture and physical properties. By taking into account both a good nutritional contribution and favorable organoleptic characteristics, energy bars are a good option for a healthy, ready-to-eat food. Thus meeting the needs of the population, due to the large number of elements with proven biological activity in humans [7].

In accordance with what was mentioned above, the objective of this research was to formulate and physically and chemically characterize an energy bar made from wheat flour and amaranth flour with a high nutritional value.

Materials and Methods

Materials

The raw material (wheat flour, amaranth flour, egg, sugar, baking powder, cornstarch, butter, peanuts, grapes, almonds and jam), was obtained commercially in a local market in San Juan Bautista Tuxtepec, Oaxaca (Mexico).

Preparation

It was performed according to the method described by [8], with some modifications. Wheat and amaranth flour (100:0, 75:25, 50:50, 25:75, and 0:100%) were mixed at different concentrations. The ingredients (egg, sugar, baking powder, cornstarch, butter, peanut, grapes, almond and jam) were added and mixed manually until obtaining a homogeneous paste, then they were baked at 180 °C for 40 min, all formulations were performed in triplicate.

Physicochemical characterization of the bars

Water activity (Aw)

Water activity was determined using the Aqualab 4TEV equipment (Decagon devices, Inc., Pullman, W.A). Which was preheated for 20 min until the equipment reached the appropriate temperature (25 °C). Subsequently, 2 g of the crushed sample was placed in the equipment and the reading was taken on the hygrometer. The sample was removed until the equipment emits green light [9].

Moisture determination

The determination of moisture was carried out by the total solids and humidity method. Aluminum trays were used at constant weight. 3 g of homogeneous sample were weighed in the trays and placed in an oven for 24 h, maintaining the temperature at 70°C ± 3°C. At the end, they were placed in a desiccator for 30 min and weighed to later perform the calculations, according to what was established by [10].

Color determination

The color of the energy bars was determined following the methodology of [11] with some modifications, using a Hunter Lab tristimulus colorimeter (MiniScan Hunter Lab, model 45/0L, Hunter Asociates Lab., Ind., Reston Virginia U.S.A). The values L* [Lightness, from 0 (black) to 100 (white)], a* [from -60 (green) to +60 (red)] and b* [from -60 (blue) to +60 (white) were obtained. yellow)]. The color palette and code will be obtained with the EasyRGB (2020) color search engine.

Texture determination

Texture profile analysis (TPA) of the bars was performed using a texturometer (TA. XT plus, Stable Microsystems Inc). The parameters evaluated were: hardness, cohesiveness, adhesiveness and gumminess. The tests were carried out at a speed of 10 mm/s and a penetration distance of 0.5 mm using a 5 mm cylinder and a 500 N load cell [12].

Statistic analysis

The values obtained for each characteristic were subjected to a one-way analysis of variance with a significance interval of 95% ($p < 0.05$), where the effect of flour concentrations on the physicochemical and texture characteristics of the bars. The differences between the means were analyzed using a Tukey significant difference test, using the Statistica V. 10.0 program (StatSoft, Inc. 1984-2008, USA).

Results and Discussion

Preparation of energy bars

Preliminarily, it was observed that as the concentration of amaranth flour increased, the elasticity of the dough decreased, this gives us indications that there is little relationship up to a certain degree of concentration between wheat flour and amaranth flour.

The dough of formulation 1 (wheat flour/amaranth 100:0) and 2 (wheat flour/amaranth 75:25) behaved in such a way that it was difficult to knead (longer kneading time) which is characteristic of wheat flour. However, although the bar with formulation 2 contained 25% amaranth flour, it was still not enough to obtain a less adhesive dough and thus reduce kneading time. The opposite is true with formulation 3 (wheat flour/amaranth 50:50), in which it was observed that the dough achieved the required consistency within a short kneading time, which is related to the percentage of lipids (7.4%) it contains. amaranth flour, which makes the dough have greater texture and cohesiveness, in accordance with the above, physically it was observed that formulation 3 (wheat flour/amaranth 50:50), presented the best characteristics, which is shown in figure 1.

Figure 1: Physical appearance of the energy bar (formulation 3).

Regarding the bar of formulation 5 (wheat flour/amaranth 0:100), the dough was very difficult to handle, under these conditions it was not possible to make the bar, so it was decided to make a cookie, this possibly because amaranth flour does not have the ability to form gels and films that help with elasticity and cohesiveness as wheat flour does, according to what was mentioned by, [13] wheat flour has these great properties mentioned above, that achieve the production of baking and pastry products with the most desirable characteristics for the consumer.

Physicochemical characterization of energy bars

The results obtained in the physicochemical characterization are shown in table 1. With respect to the data obtained in water activity, it can be observed that the bars are within the range of foods with intermediate humidity, which is an indication that influenced determined by the addition of jam to the bar, with these values we can determine the shelf life of the product [14], since the greater the amount of water available in the food, the more easily germs can thrive. It was found that there was no significant difference in the moisture content of the five bars, which results in a more pasty, adhesive bar that needs to be chewed more to be able to swallow it, since the moisture percentage is high.

Bar (Wheat flour: amaranth flour)	Water activity (Aw)	Moisture (%)	Colorimetry			
			L*	a*	b*	Color palette
100:0	0.70 ± 0.01^{c}	87. 67 ± 1.17^{a}	48.64 ± 3.54^{a}	5.04 ± 1.73^{b}	26.66 ± 2.12^{a}	
75:25	0.68 ± 0.01^{b}	87.64 ± 4.17^{a}	46.84 ± 2.83^{a}	10.77 ± 1.70^{a}	16.95 ± 3.14^{b}	
50:50	0.75 ± 0.00^{e}	89.04 ± 2.88^{a}	48.12 ± 1.63^{a}	9.58 ± 0.69^{a}	24.14 ± 1.90^{a}	
25:75	0.71 ± 0.00^{d}	86.22 ± 5.69^{a}	38.01 ± 1.53^{b}	10.55 ± 0.92^{a}	27.45 ± 1.05^{a}	
0:100	0.59 ± 0.01^{a}	81.34 ± 1.74^{a}	46.08 ± 1.62^{a}	9.93 ± 0.52^{a}	17.78 ± 0.69^{b}	

Table 1: Effect of the percentage of wheat flour and amaranth flour on some physicochemical properties. Results represent the average of 4 repetitions ± SD. Equal letters in the same column indicate that there is no significant difference ($p > 0.05$).

In the color determination it was observed that the color is within the reddish brown colors. In bar 1 (wheat flour/amaranth 100:0) a dark brown color was obtained, which could be due to the fact that the bar was varnished with egg, so at the time of cooking there was a change in the original color. Because of this. Increasing the concentration of amaranth flour influenced the color of the loaf. However, a gradual change in color is not noted, which is why it is proposed to evaluate in more detail the influence not only of the flours, but of the remaining ingredients on the final color of the product. These results can be compared with those reported by [15], who obtained similar values in the parameters of L* (luminosity), however in the parameters of a* (2.67) and b* (25.23) they were lower, these differences may be due to the composition and physical characteristics of the ingredients used when making it, and also to the temperatures used.

Texture analysis

The results obtained in the texture analysis of the energy bars are shown in table 2.

Bar	Hardness (N)	Adhesiveness (Nmm)	Cohesion	Gummyness (N)
100:0	68.37 ± 6.36^{ab}	-0.00 ± 0.00^{a}	0.47 ± 0.04^{a}	32.21 ± 0.85^{a}
75:25	79.52 ± 7.45^{b}	-0.01 ± 0.01^{a}	0.52 ± 0.16^{ab}	41.46 ± 4.62^{a}
50:50	168.48 ± 9.98^{c}	-0.00 ± 0.00^{a}	0.81 ± 0.34^{ab}	108.63 ± 0.87^{b}
25:75	45.05 ± 10.80^{a}	-0.00 ± 0.00^{a}	1.11 ± 0.49^{ab}	96.44 ± 1.97^{b}
0:100	356.61 ± 24.91^{d}	-0.07 ± 0.04^{b}	1.15 ± 0.25^{b}	350.02 ± 1.04^{c}

Table 2: Effect of the concentration of wheat flour and amaranth flour on the texture profile of energy bars. Results represent the average of 4 repetitions ± SD. Equal letters in the same column indicate that there is no significant difference ($p > 0.05$).

In the consistency or hardness of foods, a low value is always preferable in foods [16]. It was observed that the bar with formulation 5 (wheat flour/amaranth 0:100) was the one that needed the greatest compression force, on the other hand, the bar with formulation 4 (wheat flour/amaranth 25:75) showed less hardness, since less force was required to be applied. The difference between these bars may be due to the fact that in formulation 5 (wheat flour/amaranth 0:100), as stated above, it was made in the form of a cookie which could be more susceptible to temperature and thus achieve greater hardness in the bar. For cohesiveness, the values closest to zero indicated that the greatest amount of cell walls were broken during the first compression. This means that the area of the curve of the second compression was much smaller compared to the first and that the bars do not have the ability to recover, their viscoelasticity is almost zero. With respect to adhesiveness, all bars have a certain degree of stickiness, possibly because the addition of butter, roe and sugar helps give this profile. The gumminess showed that the bar with formulation 5 (wheat flour/amaranth 0:100) had greater gumminess, followed by formulation 3 (wheat flour/amaranth 50:50); This is because in formulation 5 (wheat flour/amaranth 0:100), the preparation was different (gallea) and in formulation 3 (wheat flour/amaranth 50:50), because a balance was found between the two. flours to be able to relate to each other and increase gumminess. The texture of the bar is the result of the water content and the composition, according to what was reported by [17]. Both hardness, adhesiveness, cohesiveness and gumminess increase with an increase in moisture content while elasticity increases with an increase in moisture content [18].

Conclusion

In this study, a bar was made based on amaranth and wheat flour as a proposal for a functional food. The quantities of wheat and amaranth flour were determined according to the characteristics that they could contribute to the bar, such as texture and flavor. The amounts of butter, salt, sugar, cornstarch and baking powder were adjusted to the combination of flours, leaving a standard for the five formulations made.

It was determined that the gradual addition of amaranth flour influenced the color of the loaf and the texture profile, since the composition of amaranth flour, such as fat and protein, is greater than that of wheat flour, which It suggests that this influences these parameters due to the relationships that can be carried out intrinsically within the food. It is necessary to carry out a more rigorous and complete analysis in order to establish the optimal formulation, accompanied by a sensory analysis that can provide support in order to result in a bar that meets both the physicochemical, texture and sensory conditions.

Preliminarily, we can conclude that formulation 3 (wheat flour/amaranth 50:50) was the one that obtained the best physicochemical and texture characteristics. From these results, it is possible to standardize the processing and find the optimal conditions. of the process for making bars with this formulation.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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