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Quality evaluation of oat flour and wheat flour blends for cookie production

Evaluación de calidad de mezclas de harina de avena y harina de trigo para galleta

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Abstract

In the present study the physicochemical, rheological and sensory quality of mixtures of oat flour and wheat flour for cookie was evaluated. The experimental material was used oats cultivar Turqueza and wheat variety Urbina S2007. Five formulations of mixtures of oat flour and wheat flour were prepared treatments. The experiment was evaluated using a simple ANOVA and Tukey's test at P≤0.05 indicating significant differences in all variables studied. The Formulation 4 (25:75) has been associated parameters biscuit good quality, sedimentation volume (30.3 ml), kneading time (3.0 min), stability in kneading (3.0 min), tolerance to over-Kneading (7.3 mm) mixogram height (46.6 mm), dough strength (88.0 Wx10-4J), the relationship tenacity-extensibility (1.3 PL), factor cookie (5.9). Sensory evaluation cookie by 50 untrained panelists indicated preference formulation 4 (25:75) with respect to the attributes of taste, texture and appearance. The work allowed us to evaluate the functionality of the blending of wheat flour and oats to get a cookie.

Sedimentation, Mixogram, Alveogram, Biscuit factor, Sensory attributes

Resumen

En el presente estudio se evaluó la calidad fisicoquímica, reológica y sensorial de mezclas de harina de avena y harina de trigo para galleta. El material experimental utilizado fue avena variedad Turqueza y trigo variedad Urbina S2007. Se prepararon cinco formulaciones de mezclas de harina de avena y harina de trigo como tratamientos. El experimento se evaluó aplicando un anova simple y una prueba de Tukey a P≤0.05, indicando diferencias significativas en todas las variables de estudio. La Formulación 4 (25:75) ha sido asociada parámetros de buena calidad galletera, volumen de sedimentación (30.3 ml), tiempo de amasado (3.0 min), estabilidad al amasado (3.0 min), tolerancia al sobreamasado (7.3 mm), altura del mixograma (46.6 mm), fuerza de la masa (88.0 Wx10-4J), la relación tenacidad-extensibilidad (1.3 PL), factor galletero (5.9). La evaluación sensorial de la galleta por 50 panelistas no entrenados indica preferencia de la formulación 4 (25:75) respecto a los atributos de sabor, textura y apariencia. El trabajo permitió evaluar la funcionalidad de la mezcla de harina de trigo y harina de avena para obtener una galleta.

Sedimentación, Mixograma, Alveograma, Factor galletero, Atributo sesoriala

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Introduction

In Mexico, oats are the fourth most produced cereal with 91, 049.05 tons of grain per year. The use of oats as fodder has increased. The problem is that the above, affects the marketing of oats for human consumption, considering the low demand and that the Mexican diet does not include the regular consumption of this grain due to lack of information on its nutritional content and lack of bread products (SIAP, 2015).

In Mexico, according to SIAP (2015), the main grain oat producing states in 2013 were Chihuahua, Mexico, Zacatecas, Durango and Hidalgo.

Ubicación	Producción (Ton)	Rendimiento (Ton/Ha)
Baja California	545.42	0.55
Chihuahua	57,227.95	2.01
Coahuila	276.3	2.11
Durango	2,951.50	3.02
Hidalgo	4,670.05	1.07
Jalisco	2,185.80	3.52
México	16,604.37	1.46
Tlaxcala	1,743.80	1.89
Zacatecas	4,843.86	3.2
	91,049.05	**1.84**

Table 1 Oat production in Mexico, year 2013
Source: SIAP, 2015

According to Villaseñor et. al. (2009), the oat variety (Avena sativa L.) Turquesa is of spring habit and was obtained in the Oat Breeding Program of the Valle de México Experimental Field (CEVAMEX) by genetic recombination and selection. The cross that gave rise to the variety was made at the Bajío Experimental Field (CEBAJ) during the fall-winter cycle of 2003. Turquesa was obtained from a simple cross between the Experimental F2 line CV-83(5-0C) 8C-0C and the variety Karma.

In the segregation generations, the combination of mass or population selection methods and derived families was applied, and in generation F6 the line that generated Turquesa was obtained. Peeled oats are composed of various macronutrients and micronutrients, as well as fiber and natural antioxidants. Carbohydrates are the major components. Starch is the carbohydrate present in the greatest quantity and is composed of amylose and amylopectin chains.

Fiber is divided into soluble and insoluble and is the main contributor to the reduction of cholesterol levels in the blood. The amount of protein varies considerably, and the determining factor is the environmental conditions during growth. Oats are one of the cereals richest in protein, but they do not form gluten, so they are not breadable (Welch R. and McConnell J.; 2001). In contrast, wheat produced in Mexico is 3,357,306 tons, and this represents 5% of world production. Bread products are obtained from wheat, and Mexico ranks 6th in the export of cookies and 12th in the export of bread and pasta (SIAP, 2015).

Since the refined flour produced by milling the grain allows the production of white flours. Soft wheats that produce white refined flours are in great demand for the production of cakes and breakfast cereals. Additionally, their use is recommended for the production of wholemeal flours, since these are considerably lighter than those resulting from amber and red wheat (Solís et. al.; 2008).

Ubicación	Producción (Ton)	Rendimiento (Ton/Ha)
Baja California	516,479.78	5.95
Chihuahua	155,274.23	5.44
Coahuila	25,086.26	3.41
Durango	12,857.14	3.82
Guanajuato	74,575.03	2.43
Hidalgo	3,541.28	1.66
Jalisco	101,615.58	3.31
Michoacán	63,469.65	2.52
México	24,662.76	2.67
Nuevo León	53,923.51	2.17
Oaxaca	10,152.39	0.98
Puebla	7,333.12	1.75
Sinaloa	81,747.39	4.63
Sonora	2,089,841.43	6.86
Tlaxcala	90,575.20	2.67
Zacatecas	12,920.55	1.67
	3,357,306.90	**5.29**

Table 2 Wheat production in Mexico, year 2013
Source: SIAP, 2015

According to SIAP (2015), wheat production in Mexico is centralized in the states of Sonora, Jalisco, Chihuahua and Baja California.

The variety of flour wheat for cracker (Triticum aestivum L.) is Urbina S2007. It is of spring habit and was obtained by hybridization and genetic selection through the method of mass F3 crosses in the wheat breeding program of INIFAP at the Bajío Experimental Field (CEBAJ).

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The cross that gave rise to this variety was made in 2000. The female parent of Urbina S2007 involved four different genotypes recombined in five crosses, and the male parent was the Casilda/Centella cross. The Urbina S2007 variety is of spring growth habit, semi-dwarf, 91 cm tall; intermediate vegetative cycle, with 77 days to flowering and 124 days to physiological maturity. The Urbina S2007 variety has white grain, due to the low pigment content, both in the endosperm and in the pericarp of the grain; this is a desirable characteristic in flour wheat.

Refined wheat flour allows the preparation of fresh doughs and baked goods with a soft texture that keeps the processed product longer. When a grain is refined, most of the bran and part of the germ are removed, which results in losses of fiber, vitamin B, vitamin E, minerals, unsaturated fats (Slavin J. et al.; 2004).

According to the above, it is possible to use mixtures of oat and wheat flour formulations that are functional to obtain good quality doughs and cookies.

The objective of this project is to evaluate the biscuit suitability of oat flour and wheat flour formulations based on their physicochemical, rheological and sensory quality.

Methodology to be developed

Place of experimentation

The work was carried out in the wheat quality laboratory at the Experimental Field of the Valle de Pecuarias (CEVAMEX-INIFAP).

Pecuarias (CEVAMEX-INIFAP), located at Km 13.5, Los Reyes- Texcoco highway, Coatlinchan, Texcoco, State of Mexico.

Experimental material

Turquoise oats were grown under seasonal conditions in the town of Coatepec, State of Mexico, during the spring-summer 2014 growing season.

Urbina S2007 wheat variety grown under irrigated conditions at the Bajío experimental field in Roque, Guanajuato, in the Fall-Winter 2014 cycle.

Methods and equipment

Grain samples of both wheat and oats were cleaned of impurities such as stones, husks or foreign material.

To condition the wheat, the hectoliter weight was determined by the method (AACC Method 55-10), hardness by the pearling method (AACC Method 55-20), moisture by the FOSS NIR System method (AACC Method 39-10), and moisture by the FOSS NIR System method (AACC Method 55-20).

Once the wheat was conditioned, it was milled using a Brabender Model 880-200 mill (AACC Method 26-20). The oats were hulled and heat treated in an oven at 100 °C for 12 hr to inactivate the oxidative enzymes 12 hr to inactivate the oxidative enzymes; and then milled in a hammer mill with a 60-100.

With wheat flour and oat flour, the mixtures to be evaluated as treatments were prepared as follows:

	Tipo de Mezcla				
Relación	1	2	3	4	5
Harina Avena (%)	100	75	50	25	0
Trigo (%)	0	25	50	75	100

Table 3 Formulated flour blends

The flour mixtures were subjected to the Zeleny sedimentation test (AACC Method 56-61). Subsequently, the rheology of the dough was evaluated by means of Chopin's alveograph using Alveolink NG software (AACC Method 54-30) and Mixograph (AACC Method 54-40).

The cookies were then processed by the (AACC Method 10-5OD) determining the biscuit factor.

Finally, the sensory evaluation of the cookies was carried out with 50 untrained panelists applying a preference test for three sensory attributes taste, texture and appearance.

Statistical analysis

The analysis was performed using the SAS statistical software version 9.1, applying a completely randomized experimental design and a Tukey test≤0.05 to indicate significant differences between formulations (SAS, 2002).

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Results

Variable behavior

Table 1 and Table 2 show the mean squares for each of the variables analyzed. Significant differences were observed between combinations for each of the variables measured, which indicates that the mixtures of different proportions of oats to wheat flour modify the sedimentation volume, the characteristics of kneading such as time, stability and tolerance, as well as significantly modify the variables measured in the alveograph, such as strength, tenacity, extensibility and the tenacity/extensibility ratio.

This consequently affected its biscuit quality. This is in agreement with that published by (Czubaszek and Karolini- Skaradziñska, 2005).

Cuadro 1. Cuadrados medios del análisis de varianza de variables de fisicoquímicas y mixográficas de masa de la mezclas de harinas de avena y trigo.

FV	GI	HH	VS	TA	EA	ALM	TSA
COM.	4	1.8**	457.0**	0.9**	10.0**	62.0**	22.7**
Media		10.8	24	3	42	48	5.3
CV		0	6.2	11	8	5	16
Error	10	1.8	2.2	0.1	0.1	5.9	0.7
Total	14						

* *= significativo (α = 0.05); CV= coeficiente de variación; FV= fuente de variación; COM. = combinación de harinas; GI = grados de libertad; HH= humedad de la harina; VS = volumen de sedimentación; TA =tiempo de amasado; EA= estabilidad al amasado.

Cuadro 2. Cuadrados medios del análisis de varianza de variables alveográficas de masa y galletas de mezclas de harinas de avena y trigo.

FV	GI	P	L	W	PL	FG
COM.	4	1437.0**	21840.0**	26324.1**	37.5**	0.4**
Media		62.8	79.1	122.8	2.8	6.5
CV		4.8	21.1	8.2	15.1	2.5
Error	10	9.4	278.6	101.7	0.2	0.02
Total	14					

* *= significativo (α = 0.05); CV= coeficiente de variación; FV= fuente de variación; COM. = combinación de harinas; GI= grados de libertad; P =tenacidad de la masa; L= extensibilidad de la masa; W= fuerza de la masa; PL =relación tenacidad extensibilidad; FG =Factor galletero.

Cuadro 2. Cuadrados medios del análisis de varianza de variables alveográficas de masa y galletas de mezclas de harinas de avena y trigo.

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Moisture and Sedimentation

Volume evaluation

Table 3 shows the means of the variables measured for the combinations analyzed. Moisture and sedimentation volume decreased as the percentage of oat flour in the mixture increased, which is in agreement with (Luczycka et. al.; 2013).

Cuadro 3. Resultados de humedad y sedimentación de las formulaciones de harina de avena y trigo.

Tratamiento	Composición	HH (%)	VS (ml)
Formulación 1	100% A	9.9 e	10.3 e
Formulación 2	75 %A-25%T	10.3 d	15.0 d
Formulación 3	50%A-50%T	10.9 c	23.0 c
Formulación 4	25%A-75%T	11.3 b	30.3 b
Formulación 5	100% T	11.9 a	41.3 a

A = harina de avena; T = harina de trigo; HH = humedad de la harina.; VS = volumen de sedimentación; [a b] indican diferencia significativa a P≤0.05

Mixographic Evaluation

Table 4 shows the mixographic results of the oat and wheat flour formulations evaluated.

Cuadro4. Resultados de variables mixográficas de formulaciones de harinas de avena y trigo.

Tratamiento	Composición	TA (min)	EA (min)	ALM (mm)	TSA (mm)
Formulación 1	100%A	3.3 a	7.4 a	50.5 ba	3.0b
Formulación 2	75 %A-25%T	3.5 a	4.7 b	45.6 b	2.0b
Formulación 3	50%A-50%T	3.4 a	4.8 b	44.3 b	4.5b
Formulación 4	25%A-75%T	3.0 ba	3.0 c	46.6 b	7.3 a
Formulación 5	100%T	2.2 b	2.1 c	55.6 a	8.6 a

A = harina de avena; T = harina de trigo; TA = tiempo de amasado; EA = estabilidad al amasado; TSA = tolerancia al sobreamasado; ALM = altura del mixograma; [a,b] indican diferencia significativa a P≤0.05.

Table 4

According to the above information, it was observed that the time and stability to overkneading decreases as the oat flour concentration decreases in the formulation. The mixogram height was higher in formulation 5. The lowest tolerance to overkneading was presented in formulation 4 and 5 successively, which is in agreement with what was reported by Sobczyk (2008).

Evaluation of Alveagrafica

Table 5 shows the results of the alveographic characteristics evaluated in the flour formulations.

Cuadro4. Resultados de variables mixográficas de formulaciones de harinas de avena y trigo.

Tratamiento	Composición	TA (min)	EA (min)	ALM (mm)	TSA (mm)
Formulación 1	100%A	3.3 a	7.4 a	50.5 ba	3.0b
Formulación 2	75 %A-25%T	3.5 a	4.7 b	45.6 b	2.0b
Formulación 3	50%A-50%T	3.4 a	4.8 b	44.3 b	4.5b
Formulación 4	25%A-75%T	3.0 ba	3.0 c	46.6 b	7.3 a
Formulación 5	100%T	2.2 b	2.1 c	55.6 a	8.6 a

A = harina de avena; T = harina de trigo; TA = tiempo de amasado; EA = estabilidad al amasado; TSA = tolerancia al sobreamasado; ALM = altura del mixograma; [a,b] indican diferencia significativa a P≤0.05.

Table 5

Regarding the alveographic characteristics, it was not possible to determine them in formulation 1 and formulation 2, due to the inappropriate behavior of the alveograph, since this equipment has been designed for the analysis of refined wheat flours.

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However, it was carried out for formulation 3, formulation 4 and formulation 5. The results indicate significant difference of formulation 3, which indicates higher tenacity, extensibility, lower bulk strength and higher tenacity/extensibility ratio, agrees with that reported by Bloksma and Bushuk (1988).

This indicates that strength and extensibility decreased as the percentage of oats in the mix increased, while toughness and toughness/extensibility ratio increased, which is consistent with Sobczyk, (2008).

Evaluation of the Biscuit Factor

The biscuit factor increased as the proportion of oats in the mixture increased, so that it presented the highest value of this variable when the cookie was made with formulation 3 and corresponded to an excellent quality of the cookie made with 100% oat flour.

Cuadro 6. Resultados de factor galletero de formulaciones de harina de avena y trigo.

Tratamiento	Composición	FG
Formulación 1	100% A	6.9 a
Formulación 2	75 %A-25%T	6.8 a
Formulación 3	50%A-50%T	6.5 ba
Formulación 4	25%A-75%T	6.2 b
Formulación 5	100% T	6.1 b

A = harina de avena; T = harina de trigo; FG = Factor galletero;[a,b] indican diferencia significativa a P≤0.05.

Table 6

Figure 1 shows the cookie appearance of the oat and wheat flour formulations. a) Formulation 5, b) Formulation 4, c) Formulation 3, d) Formulation 2 and e) Formulation 1.

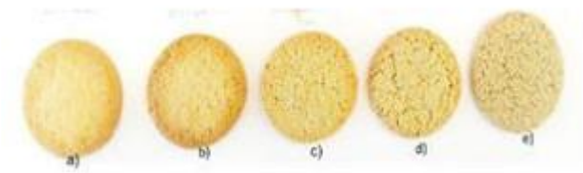

Figure 1 Cookies obtained from evalaudas formulations

Sensory Evaluation of Cookies

The sensory evaluation of the cookies is shown in graph 1. In this graph it was observed that formulation 4 and 3, respectively, were the most preferred in the sensory attributes of flavor, texture and appearance.

Regarding the preference of the taste attribute, the highest preference is for formulation 4 and formualtion 2.

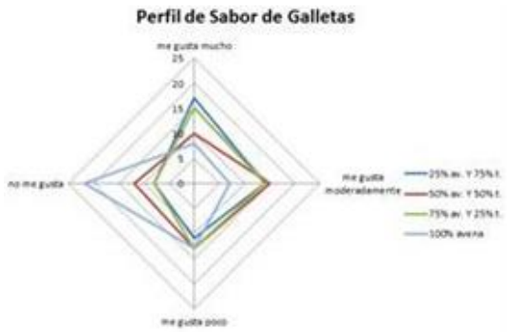

Figure 2 Cookie flavor attribute preference

The cookie texture represented the highest preference for formulations 4 and 2.

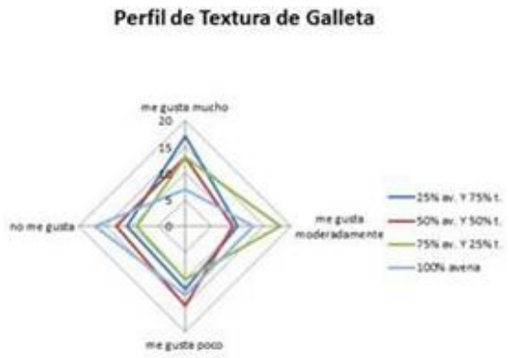

Figure 3 Cookie texture attribute preference

The cookie texture showed a greater preference for formulations 4 and 3.

Figure 4 Cookie appearance attribute preference

As an observation of the panelists, the higher the concentration of oats in the formulation, the more bitter the taste of the cookie.

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Conclusions

The formulation of 4 (25% oat flour and 75% wheat flour) showed the best physicochemical, mixographic, alveographic, biscuit quality and sensory characteristics.

With the previous formulation, the technological functionality is fulfilled, so it will be necessary to evaluate the nutritional contribution.

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