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Article **ECORFAN-Ecuador Journal**

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Varietal crosses, an alternative of improved corn seed use in the Mexican tropics

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Resumen

Durante la temporada de verano de primavera en 2013 y otoño de invierno de 2013/14, se evaluaron en la estación experimental de Cotaxtla Ver., 40 cruces de variedades de maíz, 21 sintéticos experimentales y tres híbridos, utilizados como controles, bajo diseño de celosía alfa 8x8 con 64 entradas y dos Replicaciones con densidad de plantas de 62.500 plantas ha-1. Se registraron los rasgos: Días a borla, altura de planta, aspecto de planta y oído, cobertura de cáscara mala y pudrición de oreja. Del análisis combinado, se encontraron diferencias significativas para los genotipos (G) y Ambientes (E) para todos los rasgos evaluados; La interacción GxE sólo fue significativa para el rendimiento de grano y la putrefacción de la oreja. Las cruces registraron un rendimiento promedio de 5.13 tha-1, 28% más que las variedades sintéticas de los padres; Además, eran más altos, con mejor aspecto de planta y oído, mejor cobertura de la cáscara, y menos podredumbre de la oreja. Se encontraron 31 cruces significativamente diferentes, algunos de ellos fueron: SINT6CxSINT4B, SINT2BxSINT10C, SINT2Cx SINT4B, SINT1CxSINT2B, SINT2CxSINT3SEQ, TS6xSINT6C con el mejor valor de heterosis (63,3%) y V-537CxSINT9C con proteína de alta calidad, 25% más de rendimiento que el VS- 536 la variedad de maíz sintético más utilizada en el sureste de México.

Cruces de variedades, maíz, heterosis

Abstract

During spring summer season in 2013 and fall Winter season 2013/14, there were evaluated in Cotaxtla Experimental Station Ver., 40 maize variety crosses, 21 experimental sinthetics and three hybrids, used as checks, under alpha lattice design 8x8 with 64 entries and two replications with plant density of 62,500 plants ha^{-1}. There were registered the traits: Days to tassel, height of plant, plant and ear aspect, bad husk cover and ear rot. From the combined analysis, there were found significant differences for Genotypes (G) and Environments (E) for all evaluated traits; The GxE interaction was only significant for grain yield and ear rot. Crosses registered an average in yield of 5.13 tha^{-1}, 28% more than the synthetic varieties parents; besides, they were higher, with better plant and ear aspect, better husk cover, and less ear rot. There were found 31 crosses significant different, some of them were: SINT6CxSINT4B, SINT2BxSINT10C, SINT2Cx SINT4B, SINT1CxSINT2B, SINT2CxSINT3SEQ, TS6xSINT6C with the best heterosis value (63.3%) and V-537CxSINT9C with high quality protein, 25% more yield than VS-536 the most used synthetic maize variety in the southeast of México.

Variety crosses, maize, heterosis

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Introduction

The corn crop is the most important because it is the main food of the population, because of its area planted, value of production and occupy 20% of the economically active population. Particularly in Mexico, 8.2 million hectares are planted with corn, with a production of 22 million tons of grain, and an apparent per capita consumption of 209.8 kg. (Morris and Lopez, 2000). For direct consumption in human food, 12.3 million tons are used, of which 36% is through the flour industry and 64% through the dough and tortilla industry in the process of nixtamalización; Of corn is obtained 59% of the energy and 39% of the protein that the Mexican ingests (SAGARPA, 2012).

2.5 million hectares are planted annually in southeastern Mexico. Of these, one million are included in agronomic provinces of good and very good productivity and 100,000 hectares are planted under irrigation conditions (Sierra et al., 2004) . In this area, hybrid sowing is recommended in which the benefits of heterosis in the commercial production of corn are exploited, since they express their genetic potential to the maximum under conditions of climate, soil and management by farmers (Gómez, 1986, Sierra et al., 1992 Sierra et al., 2004 Sierra et al., 2004a Sierra et al., 2005, Vasal et al., 1992).

In the commercial production of hybrids the type of gene action is taken advantage of, deviation of additivity when crossing different individuals genetically, as long as their genes are compatible, that is to say the yield is greater as the genetic divergence is greater (Reyes, 1985) . On the other hand, Vasal et al., (1993) found that the interpopulation hybrids were superior in performance over the intra-population of 8 to 15.6%.

Thus, for the tropical region, the double cross hybrids H-503 and H-507 were formed and in which the heterotic pattern Tropic moist x Dry Tropic (Reyes 1971) was used. Serra et al., 2004, used as in-tester the inbred lines of High Specific Combinatorial Aptitude (ACE), LT154, LT155, CML247 and CML254, which allowed to identify outstanding advanced lines and to separate heterotic groups that form superior hybrids.

During the last years hybrids and varieties with great potential of yield, adapted to the tropical humid conditions of the Southeast of Mexico, were generated, among them of current use the trilineal hybrid H-520, the synthetic variety of free pollination VS-536, the genotypes Of high-quality H-519C, V-537C, V-556AC and recently released H-564C high-quality hybrid protein (Sierra et al., 2004a)

Varietal crosses can be an alternative in the commercial production of corn because it takes advantage on the one hand the advantages offered by heterosis in the commercial production of the hybrid, seed production and the maintenance of their parents because they are synthetic varieties Of free pollination (Reyes, 1985).

The objectives of this research were: To know the yield and agronomic characteristics of corn varietal crosses for the Mexican tropics and to determine the heterosis with respect to the best progenitor

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Materials y methods

Localization. The formation and evaluation of corn varietal crosses was carried out at the Cotaxtla Experimental Field, belonging to INIFAP, located in the municipality of Medellín de Bravo, Veracruz, located at 18 ° 56 'North latitude and 96 ° 11' West Longitude And an altitude of 15 msnm.

The climate according to the classification of köppen modified by García (1981), with an area of influence in the Humid Tropics of Mexico, includes the climatic group A (Aw, Am and Af), warm humid and subhumid with average annual temperature of 25 ° C and annual precipitation of 1400 mm, distributed from June to November. The soil is of alluvial origin, deep, with medium texture throughout the profile, slope less than 1%, and good drainage and slightly acidic pH (6.6).

Germplasm used. In the present research, 40 varietal crosses, 21 experimental crosses, of which 12 have been formed with lines converted to the high quality character of protein and denominated SINT 1, 2, 3, 4, 5, 6, 7 , 8, 9, 10 and 11C and the variety V-537C with high quality of protein, the rest of the experimental synthetics are of normal endosperm; Hybrid H-520, H-564C and H-519C used as controls were also included.

Process. During the spring summer 2013 and autumn winter 2013/14 cycles, 40 maize varietals, 21 varieties and three control hybrids were prepared and evaluated, which were distributed under an 8x8 alpha lattice design with 64 treatments and two replicates in plots of 1 Furrow 5m long separated at 80 cm and with a density of 62,500 ha-1 plants. Weed control was based on Atrazine in preemergent application; It was fertilized with the formula 161-46-00 and pests of the foliage were controlled during the development of the crop.

Variables and data recording. During the development of the crop and at the time of harvest, the following variables were recorded: grain yield, plant height, days at male flowering, plant and ear aspect, ears with poor coverage and bad ears

Statistical methods. Analysis of variance was performed for all variables; the percentages registered: % poor coverage and% of rotten ears, were transformed to bliss degrees for analysis through the formula, since some plots presented values with zero. For the separation of means, the Significant Minimum Difference test was applied at 0.05 and 0.01 of probability (Reyes, 1990). Comparisons of cross groups and synthetic parent varieties were made and the t-test at 0.05 and 0.01 probability was applied. Also, the percentages of heterosis with respect to the best progenitor were calculated as follows:

$$\% \text{ de Heterosis} = \frac{F1 - \text{Best parent}}{\text{Best parent}} \times 100$$

Results and discussion

From the analysis of combined variance for the following variables: Grain yield, Days at male flowering, plant height, plant and ear aspect,% of cobs with poor coverage and% of rotten ears were found statistically significant at 0.05 and 0.01 of Probability for Genotypes (G) and Environments (A) in all variables; The interaction GxA was only significant in the variables grain yield and% of rotten ears (Table 1). The highest variance was recorded for the Source of variation Environments, which means that these environments were different and that the behavior of the genotypes during the spring summer 2013 and fall 2013/14 winter cycle was also different.

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The coefficient of variation obtained for grain yield was 13.89%, a relatively low value suggesting that the conduction of the experiments and the results obtained are reliable (Reyes, 1990).

Source of variation	GL	Rend t ha^{-1}	Días a flor	Alt pl	Asp pl	Asp mz	% Cob	% Pod
Genotipes (G)	63	1.75**	9.47**	385.46**	0.37**	0.44**	3.09**	1.65**
Enviroments (A)	1	90.01**	5614.5**	22041.3**	0.75**	2.42**	16.84**	3.42*
Interaction GxA	63	3.436**	2.12 NS	197.2 NS	0.16 NS	0.22 NS	1.41 NS	1.43**
Error	126	0.435	1.695	165.84	0.17	0.165	1.485	0.84
CV (%)		13.89	2.31	6.26	16.11	17.36	41.17	28.73

GL = degrees of freedom; Rend = Yield; Alt pl = Plant height; Asp pl = Aspect of plant; Asp mz = Aspect of cob; % Cob = Percent of cobs with poor coverage; % Pod = Percent of rotten ears; CV = Coefficient of variation.

Table 1 Mean squares and significance of analysis of combined variance of maize varietal crosses for the tropics of Mexico. Cotaxtla 2013B and 2014A

Agronomic performance and characteristics

Through the DMS test at 0.05 probability (Reyes, 1990), 31 varietal crosses were found that were outstanding for grain yield and significantly exceeded the variety VS-536, the synthetic variety of maize of greater use in the Mexican southeast of 9 to 29% (Table 2). From this group of crosses stands the presence of SINT 4B, which participates in 9 outstanding combinations, SINT 10C in five combinations and the synthetics SINT 2B, SINT2C, TS6 SINT 1C and SINT 5B participating in four outstanding combinations which suggest good general combinatorial ability Of these synthetics. In relation to crosses, heterosis values were found with respect to the best progenitor from -2.2 to 63.30% (Sierra et al., 2004; Sierra et al., 2004; Sierra et al., 2004) 2005; Vasal et al., 1992; Vasal et al., 1993; Gómez et al., 1986).

The best crosses for its yield and agronomic characteristics were SINT6C xSINT4B, SINT2BxSINT10C, SINT2Cx SINT4B, SINT1CxSINT2B, SINT2CxSINT3 SEQ, TS6xSINT6C, with the best heterosis value (63.3%), V-537CxSINT9C, crosses varietal with high quality 8% More yield in relation to the trilineal hybrid H-520 and 25% more than the synthetic variety VS-536, of greater use in the southeast of Mexico and 41.3% of heterosis and also registered good aspect of plant and of cob; The synthetics SINT2BxSINT2C, SINT6CxSINT5B, SINT5B xSINT11C, SINT1BQxSINT10C, SINT4Bx SINT8C and SINT4BxV-537C with good yield and agronomic characteristics, (Reyes, 1985).In the majority of the outstanding crosses, combinations between synthetic formed with lines converted to the character of high quality of protein and synthetic ones formed with normal lines participate, which suggests genetic divergence between the progenitors (Reyes, 1985; Sierra et al., 2004; In the present study, it was observed that, in the present study.

Trat	Genealogía	Rend	% Rel	% Het	Flor	Alt Pl	Asp Pl[1]	Asp Mz[1]	% Cob	% Pod
12	SINT6CxSINT4B	5.73*	129	30.3	58.0	201.5	2.25	2.15	6.20	11.20
34	SINT2BxSINT10C	5.70*	128	24.5	57.5	214.0	2.40	1.90	12.80	7.15
5	SINT2CxSINT4B	5.65*	127	28.4	56.5	210.5	2.25	1.90	7.80	9.15
3	SINT1CxSINT2B	5.63*	127	23	56.0	201.5	2.25	1.90	8.20	9.69
4	SINT2CxSINT3SEQ	5.63*	127	32.5	56.5	217.5	2.40	2.05	8.05	5.95
22	TS6xSINT6C	5.55*	125	63.3	55.5	204.0	2.50	2.05	10.45	9.20
27	V-537CxSINT9C	5.55*	125	41.3	55.5	215.0	2.55	2.00	6.75	6.20
32	SINT2BxSINT2C	5.50*	124	20.1	57.0	211.5	2.65	2.15	9.50	5.55
13	SINT6CxSINT5B	5.48*	123	22.4	57.5	212.5	2.25	1.90	2.70	8.15
40	SINT5BxSINT11C	5.48*	123	19.7	57.0	196.5	2.50	2.05	5.70	4.90
29	SINT1BQxSINT10C	5.45*	123	23.6	57.0	205.5	2.35	2.15	17.60	9.85
37	SINT4BxSINT8C	5.43*	122	23.4	57.0	214.0	2.55	2.15	5.85	8.04
38	SINT4BxV537C	5.37*	121	22.1	58.0	202.5	2.55	1.90	2.60	7.60
6	SINT3CxSINT4B	5.28*	119	20	57.5	220.0	2.15	2.30	11.05	9.70
26	VS536xSINT9C	5.23*	118	31.4	53.5	200.0	2.40	2.30	8.80	7.95
33	SINT2BxSINT8C	5.20*	117	13.6	58.0	217.5	2.65	2.05	7.50	9.30
10	SINT5CxSINT5B	5.13*	115	14.5	57.5	215.5	2.25	1.90	4.70	7.25
24	LPSC3xSINT3C	5.13*	115	18.5	55.0	212.5	2.40	2.25	7.10	7.80
28	SINT1BQxSINT2C	5.13*	115	16.4	55.5	206.5	2.15	2.40	9.25	10.10
30	SINT1BQxSINT4B	5.13*	115	16.4	58.5	227.5	2.15	1.80	0.00	4.95
62	H-520	5.13*	115		57.5	203.0	2.30	1.65	3.60	4.15
2	SINT1CxVS536	5.10*	115	28.8	55.0	186.5	2.65	2.40	15.40	14.30
23	TS6xSINT10C	5.10*	115	32.5	56.0	210.0	2.25	2.15	5.50	4.65
59	SINT-3B	4.60	104		58.0	209.0	2.25	2.15	12.20	11.00
51	SINT-11C	4.58	103		55.0	197.5	2.80	2.65	22.25	10.85
58	SINT-2B	4.58	103		58.5	221.5	2.15	2.05	4.40	7.25
61	SINT-5B	4.48	101		57.5	206.5	2.80	2.15	6.05	10.65
55	VS-536	4.44	100		61.0	214.0	2.40	2.90	1.15	18.75
57	SINT 1BQ	4.41	99		59.0	215.5	2.55	2.55	5.30	4.80
60	SINT-4B	4.40	99		57.5	209.0	2.40	2.40	3.70	6.10
43	SINT-3C	4.33	98		56.0	203.0	2.40	2.65	7.55	20.90
42	SINT-2C	4.25	96		55.5	195.0	2.75	2.50	12.25	10.25
47	SINT-7C	4.18	94		54.5	189.0	2.50	2.80	12.95	7.45
48	SINT-8C	4.05	91		56.5	206.5	3.00	2.65	11.40	13.80
49	SINT-9C	3.93	88		55.5	193.0	3.30	2.75	10.60	16.25
50	SINT-10C	3.85	87		56.0	194.0	2.90	2.50	12.85	11.95
54	SINT3-SEQ	3.85	87		56.5	210.5	2.65	2.55	11.75	9.35
45	SINT-5C	3.75	84		56.0	208.0	2.80	2.40	7.80	7.50
44	SINT-4C	3.63	82		56.5	187.5	3.05	2.65	12.20	10.05
41	SINT-1C	3.60	81		56.5	189.0	3.25	2.75	22.15	13.20
53	LPS-C3	3.50	79		56.5	195.0	3.13	3.00	1.80	14.55
56	V-537C	3.50	79		54.0	195.5	2.90	3.30	15.70	21.00
52	TS6	3.40	77		54.0	184.0	3.25	2.65	8.80	10.10
46	SINT-6C	3.08	69		54.5	198.0	2.90	3.05	6.20	19.65
	PROMEDIO	4.75			56.46	205.1	2.56	2.34	8.92	9.83
	CME	0.435			1.70	165.84	0.17	0.17	1.49	0.84
	DMS0.05	0.925			1.80	17.85	0.57	0.57	1.68	1.27

Table 2 Yield and agronomic characteristics in corn varietal crosses for the tropics. Cotaxtla 2013B and 2014A

Comparisons and tests of t

In the comparisons and tests of t for crosses and synthetic varieties, statistical significance was found for yield and agronomic characteristics; Particularly crosses recorded an average grain yield of 5.13 tha-1, 28% more relative to synthetic parent; So the crosses showed significantly higher plant height, better plant and ear appearance, lower percentage of cobs with poor coverage and lower percentage of rotten ears (Table 3). This suggests that there is genetic divergence between the parents, which is also reflected in the values of heterosis with respect to the best progenitor that varied from -2.2 to 63.3%. (Reyes, 1971; Reyes, 1985; Sierra *et al.*, 2004; Sierra *et al.*, 2004a; Sierra *et al.*, 2005; Vasal *et al*., 1992).

Comp	RG	% Rel	Tc	Alt Pl	Tc	Asp $pl^{1/}$	Tc	Asp $mz^{1/}$	Tc	% Cob	Tc	% Pod	Tc
Cruza	5.13	128	8.89**	208	4.08**	2.46	5.54**	2.22	7.14**	8.51	3.2**	8.75	2.02*
Sint	4.01	100		201		2.77		2.62		9.95		12.6	

T0.05 (126) = 1.98; T0.01 (126) = 2.62

A = Autumn winter cycle; B = Spring summer cycle; 1 / = Rating scale from 1 to 5, 1 for best and 5 for worst; COMP = Comparison; SINT = Synthetic; RG = grain yield; % Rel = Relative percentage; Tc = t calculated; Alt pl = Plant height; Asp pl = Aspect of plant; Asp mz = Aspect of cob; % Cob = Percentage of ears with poor coverage; % Pod = Percentage of rotten ears

Table 3 Comparisons and t tests for yield and agronomic characteristics for varietal and synthetic crosses. Cotaxtla 2013B and 2014A

Conclusions

The crosses recorded an average grain yield of 5.13 tha-1, 28% more in relation to the synthetic ones. The crosses showed a better appearance of plant and cob, lower percentage of ears with poor coverage and lower percentage of ears with respect to synthetic ones. Crosses showed heterosis values in performance with respect to the best progenitor of -2.2 to 63.3%.

We found a group of 31 crosses that were outstanding for their performance and agronomic characteristics, among them: SINT6CxSINT4B, SINT2BxSINT10C, SINT2CxSINT4B, SINT1CxSINT2B, SINT2Cx SINT3SEQ, TS6xSINT6C with the best heterosis value (63.3%), V-537CxSINT9C with high quality Of protein and 25% more yield relative to the variety VS-536, SINT2BxSINT2C, SINT6C xSINT5B, SINT5B xSINT11C, SINT1BQx SINT10C, SINT4Bx SINT8C and the cross SINT4BxV-537C.

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Effect of hydrogen peroxide on broccoli seedlings (*Brassica oleracea* var. *itálica*)

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Resumen

El estado de Guanajuato es el principal productor de brócoli (Brassica oleracea var. Italicized), este cultivo como un todo se produce bajo el sistema de plantación, uno de los problemas que enfrentan los productores es la pérdida en el trasplante debido a las plantas de estrés sufren al hacerlo . La aplicación del peróxido de hidrógeno (PH) aumenta la resistencia de las plantas al estrés biótico y abiótico, por lo que el objetivo de esta investigación es evaluar el efecto de las aplicaciones foliares de PH en plántulas de brócoli, ya que se plantó la variedad Avenger 8 días después de la siembra se realizó la aplicación de PH a dosis de 0,6, 1,4 y 1,8 mM con adhesivo al 1% (Bionex®) en un diseño completamente al azar con 10 repeticiones y testigo de que sólo se aplicó adhesivo, Unidad consistía en una planta, la aplicación se hizo cada 8 días durante 3 semanas. Las variables evaluadas fueron: longitud total de la plántula, longitud del tallo, longitud de la raíz, diámetro del tallo, peso fresco, peso seco y biomasa. Las aplicaciones de peróxido de hidrógeno a dosis de 1,8 mM cada ocho días de brocoli, aumentan la longitud del tallo y el peso fresco, mientras que la dosis de 1,4 mM aumenta la biomasa de las plántulas

Peróxido de hidrógeno, plántulas, altura de la planta, longitud de la raíz

Abstract

The state of Guanajuato is the leading producer of broccoli (Brassica oleracea var. Italicized), this crop as a whole is produced under the plantation system, one of the problems facing producers is the loss in transplantation due to stress plants suffer when you do it. The application of hydrogen peroxide (PH) increases the resistance of plants to biotic and abiotic stress, which is why the aim of this research is to evaluate the effect of foliar applications of PH in seedlings of broccoli, for it was planted the Avenger variety in trays, eight days after sowing the application of PH at doses of 0.6, 1.4 and 1.8 mM was performed with 1% adherent (Bionex®) in a completely randomized design with 10 repetitions and a witness to that I was only applied adhesive, the experimental unit consisted of a plant, the application was made every 8 days for 3 weeks. The variables evaluated were: total length of seedling, stem length, root length, stem diameter, fresh weight, dry weight and biomass. Applications of hydrogen peroxide at doses of 1.8 mM each eight days broccoli seedlings, increase stem length and fresh weight, whereas the dose of 1.4 mM increase the biomass of seedlings

Hydrogen peroxide, seedlings, plant height, root length

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Introduction

Mexico is among the world's leading producers and exporters of vegetables, ranking fourth in the world (Financiera Rural, 2008). On the other hand, Guanajuato is one of the main producers of broccoli with a contribution of 60.16% (SAGARPA, 2010).

Cruciferae like broccoli, multiply by sexual seed; for the establishment of open field crops, the preparation of seedlings is required. Production begins in the seedbed, which can be an area of land or containers (trays) properly adequate to deposit the seeds and provide the optimal conditions of light, temperature, fertility and humidity, to obtain the best emergency and development in initial states until the transplant to the field (Jaramillo 2006).

The use of defense mechanisms in plants, particularly the expression and regulation of broad-spectrum resistance associated with ISR (systemic resistance induced) and SAR (acquired systemic resistance) phenomena, may serve as a viable alternative for the design of management strategies Seedlings (Mejía, 2014). Hydrogen peroxide (H2O2) is considered a signal molecule and a regulator of the expression of some genes in cells. When it accumulates in plants, it activates transcription factors that regulate different physiological processes, inhibits plant growth and development, and stimulates defense mechanisms to biotic and abiotic stress (Yu et al., 2002, Pnueli et al. 2003; Hung et al., 2005).

Due to the characteristics of this compound (highly reactive, short half-life and potent reductive oxidation of cellular components) there are few works where its exogenous application in plants is experienced. Previous experiments on different cultures revealed that H2O2 sprays inhibited stem growth and increased starch and lignin content (Foyer et al., 1997; López-Delgado et al., 1998, 2005); in others the yield and quality of production increased (Romero-Romero and Lopez Delgado, 2009). In the present work, the effect of hydrogen peroxide (H 2 O 2) on agronomic variables of broccoli plants.

Methodology

The present investigation was carried out in the greenhouses Agro Vida, Celaya; Gto; For the evaluation of hydrogen peroxide in broccoli seedlings the hybrid Avenger (Sakata®) was used, the seeding was performed mechanically in trays of 338 cavities of 7.5 mL of capacity of each well, the trays were previously disinfected with formaldehyde To 38%. As substrate was used professional Growing Mix (Sungro®) and perlite with a ratio of 2: 1 approximately, to cover the seed already emerged was used vermiculite (Sunshine®). The trays were stowed, sewed and sprinkled with Kaisen® (Metamidofos). Two days after the seimbra were uncovered and covered with vermiculite to pass to the greenhouse and placed in 32 trays per lane and the first irrigation was performed.

At 8 days after germination the treatments were applied, using a completely randomized design with 10 replicates and each experimental unit consisted of one plant. A 1.0 L manual sprayer (Trupper®) was used for the application of the treatments, applications were made once a week for three weeks. Each dose was applied 1 mL of adherent (Bionex®) per liter of water, the control was applied only water and adherent.

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No. Trat	Treatment	Concentration
1	Hydrogen peroxide	0.6 mM
2	Hydrogen peroxide	1.4 mM
3	Hydrogen peroxide	1.8 mM
4	Witness	--

Table 1 Concentration of hydrogen peroxide applied to broccoli seedlings.

The irrigations were performed daily and every third day were fertilized with the formula 20-20-20

The variables evaluated were performed 2 times per week and 10 plants per experimental and labeled unit were chosen.

Fresh Weight (g). The plants were first removed from the trays and washed well from the root, weighed and then placed in a sanitary napkin with their respective number.

Measurement of root and stem. Once the plant was already washed and weighed, the length of the root (cm) was measur

ed with a rule of 30 cm (Baco®), it was stretched in its entirety and for measuring the length of the stem (cm) was considered from the base of the stem to the first branch

Diameter of stem (mm). A vernier (Truper®) was used for this, the measurement was performed in the middle part of the stem.
Dry weight (g). After all previous measurements were taken, each seedling was placed in toilet towels and placed in an oven at 72 ° C for 3 days, after which it was weighed on an analytical balance (Adam®). Biomass (g). It was determined by difference between fresh weight and dry weight.

With the results of plant height, stem length, root length, stem diameter, fresh weight, dry weight and biomass, a variance (ANOVA) analysis was performed with 10 treatments and a control to indicate differences between treatments With PH applications. When ANOVA indicated significant differences between treatments, the Tukey's test ($p \leq 0.05$) was applied for the separation of means. For the statistical analysis the SAS system program for Windows ver. 9.0 (2002).

Results and disscusion

The effect of foliar applications of hydrogen peroxide (PH) on the variables of seedling height, stem length, root length and stem diameter of broccoli seedlings are shown in the middle square in Table 2, where The effect of the treatments was significant for the stem length variable, for the variables of plant height, root length and stem diameter no effects were observed, these values coincide with those reported by Ramírez et al. (2006) did not observe effects of treatments with salicylic acid, abcisic acid and chitosan in broccoli plants in these same variables. Sampling significantly affected all evaluated variables, whereas; The interaction of treatment by sampling affected highly to stem length and significantly to plant height and root length.

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FV	GL	CM[1]			
		Height Plant	Height Stem	Root Length[2]	Stem Diameter[3]
Trat[4](T)	3	3.16	0.18*	1.41	0.02
Muest[5] (M)	5	189.13**	2.72**	35.38**	0.86**
M x T	15	3.48*	0.24**	3.51*	0.01
Repetición	9	1.56	0.02	0.96	0.005
Error	207	2.00	0.03	1.80	0.008
Total	239				
R^2		0.71	0.70	0.79	0.71
CV		10.81	10.65	20.17	7.45

1Current Medium, 2Length, 3Diametro, 4 Treatment, 5 Sampling

Table 2 Average squares for plant height, stem height, root length and stem diameter of broccoli seedlings as a result of the exogenous application of hydrogen peroxide.

The values of the coefficient of determination ranged from 0.70 to 0.79, while the coefficient of variation was less than 21% for root length and 7.45% for stem diameter.

Table 3 shows that treatments with PH had a highly significant effect on strawberry weight and biomass of broccoli seedlings, not observing effect on dry weight, this value is in agreement with Casierra-Posada et al. (2010) Who did not observe effect on the dry weight of broccoli seedlings with zinc applications in the soil.

While for the variables of fresh weight, dry weight and biomass the effect was highly significant for sampling, the interaction treatment by sampling was highly significant for all variables under study.

The coefficient of determination was greater than 0.89 for the variables under study and the coefficient of variation observed was 16.14, 15.9 and 16.41 for the variables of fresh weight, dry weight and biomass, respectively.

FV	GL	CV		
		Peso Fresco	Peso Seco	Biomasa
Trat (T)	3	0.16**	0.0005	0.15**
Muest (M)	5	7.27**	0.074**	5.90**
M x T	15	0.07**	0.0005**	0.06**
Repetición	9	0.02	0.00007	0.02
Error	207	0.02	0.0001	0.01
Total	239			
R^2		0.89	0.90	0.89
CV		16.14	15.90	16.41

Table 3 Average squares for fresh weight, dry weight and biomass of broccoli seedlings due to the exogenous application of hydrogen peroxide.

Samples of the plant height and stem diameter variables of broccoli seedlings by foliar applications of PH had their highest level of significance at week 3 (sampling 6) when reaching the maximum values with 15.72 cm and 1.41 mm respectively, while That for the stem length the maximum value was observed in sampling 3 and 4 with values of 2.01 and 2.00 cm respectively.

The maximum root length was observed in Samples 2 and 3 with values of 7.41 and 7.04 cm respectively, is possibly to the adaptation process of the seedling.

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sample	Height Plant		Height Stem		Root Length		Stem Diameter	
1	9.28	e	1.37	d	5.13	d	1.01	d
2	12.40	d	1.93	ab	7.41	a	1.19	c
3	13.39	c	2.00	a	7.04	a	1.27	b
4	13.37	c	2.01	a	6.17	c	1.36	a
5	14.35	b	1.81	b	6.47	c	1.36	a
6	15.72	a	1.55	c	7.71	a	1.41	a

Table 4 Analysis of variance (ANOVA) for the effect of sampling in the variables seedling height, stem length, root length and stem diameter of broccoli seedlings with exogenous applications of hydrogen peroxide.

Table 5 shows the effect of the sampling on fresh weight, dry weight and biomass of broccoli seedlings sprayed with PH, where it is observed that for the fresh weight and accumulated biomass the maximum value was 1.38 and 1.25 g in The sampling 5 for each of the variables, while for dry weight sampling 5 and 6 presented values of 0.13, which were the highest values.

For the seedling height variable, there were no statistically significant differences between the applied concentrations with an average value of 13.15 cm (Table 6), these results differ from those reported by Quesada et al. (2005) who observed significant differences in seedlings of Broccoli germinated in different substrates and with a maximum growth value of the seedling of 5.8 cm. For root length no significant differences were observed between treatments.

According to the Tukey's test ($P \leq 0.05$), there was a significant variation for the variables of stem length, being the treatment with the lowest concentration of 0.6 mM in which the lowest development of the stem with 1.72 cm was observed and statistically behaving Concentrations of 1.4, 1.8 mM and the control with values of 1.74, 1.83 and 1.82 respectively, which were the highest values.

Sample	Fresh weight		Dry weight		Biomass	
1	0.18	e	0.02	e	0.15	e
2	0.74	d	0.05	d	0.69	d
3	0.83	d	0.07	c	0.75	d
4	0.94	c	0.10	b	0.84	c
5	1.38	a	0.13	a	1.25	a
6	1.25	b	0.13	a	1.12	b

Table 5 Analysis of variance (ANOVA) for the effect of sampling in the variables fresh weight, dry weight and biomass of broccoli seedlings with exogenous applications of hydrogen peroxide.

For the stem diameter the treatments with PH exceeded the control with values greater than 1.27 mm, these values are lower than those reported by Quesada et al. (2005) who observed maximum values of 5.3 mm in germinated broccoli seedlings in different substrates.

No Trat	Concent. PH (mM)	Height Plant		Height Stem		Root Length		Stem Diameter
1	0.6	13.4		1.72		6.73		1.27
2	1.4	12.75		1.74		6.5		1.27
3	1.8	13.27		1.83		6.83		1.28
4	Testigo	13.18		1.82		6.55		1.23

Table 6 Analysis of variance (ANOVA) for the effect of foliar applications of different concentrations of hydrogen peroxide on the variables seedling height, stem length, root length and stem diameter of broccoli seedlings.

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Table 7 shows statistical differences (P≤0.005) between the concentrations of PH applied foliarly in broccoli seedlings in the fresh weight, dry weight and biomass variables.

In the variable of fresh weight of broccoli seedlings the highest value of 0.96 g with the concentration of 1.4 nm is observed, this value differs with that reported by Caserra et al. (2010), which reported a value of 12 g in the Witness of a work done in broccoli with different concentrations of Zn applied to the soil.

The concentration of 1.4 mM of PH applied to broccoli seedlings affected the dry weight and biomass with the highest values of 0.09 and 0.87 g respectively, with the same values being statistically equal to 0.6 and 1.8 with the control.

No Trat	Concent. PH (mM)	Fresh weight		Dry weight		Biomass	
1	0.6	0.85	b	0.08	b	0.77	b
2	1.4	0.96	a	0.09	a	0.87	a
3	1.8	0.88	b	0.08	a	0.8	b
4	Testigo	0.85	b	0.08	a	0.76	b

Table 7 Analysis of variance (ANOVA) for the effect of foliar applications of different concentrations of hydrogen peroxide on the variables fresh weight, dry weight and biomass of broccoli seedlings.

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Industrial Quality of Bread Wheat in Mexico

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Resumen

México importa anualmente cerca del 50 % del trigo harinero panificable que consume por lo que se deben de liberar variedades de alto mejor rendimiento y calidad, que contribuyan a disminuir su dependencia. El objetivo de la presente investigación fue caracterizar con base en su calidad industrial las variedades y líneas nuevas de trigo harinero, para riego y temporal, que satisfagan las características industriales demandadas para contribuir a la disminución de las importaciones. Se estimaron las variables dureza de grano, fuerza de la masa, relación tenacidad/extensibilidad y volumen de pan. Las variedades nuevas BACOREHUIS F2015, CONATRIGO F2015, DON CARLOS F2015 y VALLES F2015 así como las líneas ND643/2*WBLL1//MUNAL/3/MUNAL#1 y GAVIA/ROM/3/PIRUL/GUI/TEMP/AGR/4/JUCH presentaron grano duro por su valor menor a 47 % asociado con masa fuerte y extensible por sus valores de W mayores a $300x10^{-4}$ J y PL menores a 1.1, respectivamente. Lo anterior se reflejó en volúmenes de pan, cercanos o mayores a 800 ml, similares a las variedades testigo. La producción basada en estas variedades permitirá cubrir la demanda de la industria nacional de la panificación.

Trigo, Calidad industrial, Mejoramiento Genético y Variedades

Abstract

Mexico imports annually about 50% of the consumed bread wheat, in order to reduce this dependence, better varieties in yield and end-use quality are needed. The objective of this research was to characterize the industrial quality of varieties and advanced lines of bread wheat, for both irrigated and rainfall wheat production, in order to identify outstanding genotypes and reduce wheat imports. End use quality estimated parameters were grain hardness, dough strength, dough extensibility and bread volume. The new varieties BACOREHUIS F2015, CONATRIGO F2015, DON CARLOS F2015 and VALLES F2015 as well as lines ND643/2 * WBLL1 / / 3-MUNAL-MUNAL #1 and GAVIA/ROM/3/PIRUL/GUI/TEMP/AGR/4/JUCH showed hard grain for its value less than 47% associated with strong and extensible dough by its W values of over 300 x 10-4 and PL less than 1.1 J, respectively. This was reflected in bread volumes close or over 800 ml, similar to the control varieties. Wheat production based on these varieties will enables meet the needs of national bread industry.

Bread wheat, industrial quality, genetic improvement, varieties

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Introduction

It is now necessary, in addition to increasing wheat wheat production in Mexico, to improve the quality of its irrigated and temporary crops to meet the demand of the national mill industry.

Therefore, in order to favor domestic production, the wheat breeding program of the National Institute for Agricultural and Livestock Forestry Research (INIFAP) must release new varieties, which combine high yield potential, tolerance to foliar diseases (yellow rust and The leaf), efficient in the use of water and with the quality demanded by the industry.

Therefore, the objective of the present investigation was to characterize, based on its industrial quality, the new lines and varieties of flour wheat for irrigation and temporary in Mexico.

Teoretical Framework

During 2014 in Mexico, 3.8 million tons of wheat were harvested; this occurred in 94.4% under irrigation conditions and the rest in temporary conditions (SIAP, 2014).

However, Mexico imported 3.1 million tons of durum wheat and strong bread dough in the United States from North America and Canada, this production is characterized by availability in the market and its harvested lots are homogeneous in its industrial quality is also obtained under temporary conditions, which reduces its production costs (CANIMOLT, 2014).

The quality characteristics of the imported wheats are protein percentages in the flour of 12.6 to 15% associated with gluten strength of 350 to 500 x10-4 J and a tensile / extensibility balanced to extensible ratio of 1.2 to 0.9, which is manifested in obtaining volumes of bread larger than 800 ml (Maghirang et al., 2006).

In such a way that Mexican wheat flour must compete, in price and industrial quality, with imported wheat.

Materials and Methods

The genotypes analyzed in irrigation, as witnesses, were BORLAUG 100, VILLA JUAREZ F2009, ROELFS F2007 and KRONSTAD F2004, as well as the new varieties BACOREHUIS F2015 and CONATRIGO F2015. In addition to the candidate lines for new varieties for irrigation: line 1 or FUERTEMAYO 2016 = ND643 / 2 * WBLL1 // MUNAL / 3 / MUNAL # 1, line 2 or FONSEC F2016 = BECARD / KACHU and line 3 or NORESTE 2016 = ND643 / 2 * WBLL1 / 4 / WHEAR / KUKUNA / 3 / C80.1 / 3 * BATAVIA // 2 * WBLL1. While in temporary the control varieties used were, ALTIPLANO F2007 and TLAXCALA F2000, and the new varieties DON CARLOS F2015 and VALLES F2015. As well as the candidate lines for release as new varieties: line 1 or TEXTOCOF2016 = ZCT / SLM // CHAZ / TEM / 4 / AGA // PVN / PCI / 3 / AGA / 5 / GAV / ROM / 6 / GAL / CMH78A544 / 7 / GAV / ROM / 3 / PIRUL / GUI / TEMP / AGR / 4 / JUCH and line 3 or CIRCE F2016 = TEMP / NORM / 4 / CHLL / ROM / 3 / PRL / VEE # 6 / MYNA / BUL / 5 / TLAX / 6 / BARB / MON / TAW / 3 / INQUILAT / KUKUNA (AltProt "14%").

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Planting of irrigation genotypes was carried out at the Bajío Experimental Field (CEBAJ) of INIFAP, in Celaya, Guanajuato; while the Valle de México Experimental Field (CEVAMEX) of the same institute was established as temporary. In both production, irrigation and temporary conditions, the technological packages recommended by INIFAP were applied.

The industrial quality analyzes were carried out in the Laboratory of Farinology of CEVAMEX. The grain hardness (%) was calculated by the pearl index in 20 g of grain, indicating the facility to partially remove its outer layers, using a standardized abrasion procedure, where values less than 47% are classified as endosperm grains hard.

Using a Brabender mill (Quadrumat Senior, CW Brabender OHG, Germany) and sifting through a mesh of 129 μ in diameter, the refined flour was obtained, which was used to obtain the alveogram, to calculate the force (W) And the tenacity / extensibility ratio (PL) of the mass, using the Chopin Alveograph (Tripette & Renaud, France) using the AACC method 54-30A (2005). The masses were classified by their W and PL. For their W, values greater than 300 × 10-4 J in strong masses, 200 to 300 × 10-4 J in strong socks and less than 200 × 10-4 J in weak. For their PL in balanced masses (PL = 1.1), extensible (PL <1) and tenacious (PL> 1.2). The volume (ml) of bread was made in 100 g of refined flour (Method 10-09, AACC, 2005) using the direct mass method and was determined in a volumetric by displacement of rapeseed (Brassica sp) seeds. The mean and range values for the analyzed variables for each of the analyzed genotypes.

Results and Disscusions

The new varieties, BACOREHUIS F2015 and CONATRIGO F2015, as well as lines 2 and 3, were characterized by grain hardness similar to the control varieties BORLAUG 100 and VILLA JUÁREZ F2009, classified as hard grain. While line 1 was classified as having a semi-hard grain value less than 47% (Table 1).

On the other hand, with the exception of lines 1 and 2 that were classified as having a strong medium mass, for their W can go from 200 to 300, the rest of the genotypes were grouped into strong masses, for their W> 300. Based on their PL, most of the genotypes were classified as extensible, by their PL <1, while lines 2 and 3 and the variety VILLA JUAREZ F2009 presented tenacious masses, by their PL> 1.2, which was associated with volumes Low of bread, contrary to what was observed in the new variety CONATRIGO F2015 who presented the highest bread volume, surpassing the best control variety KRONSTAD F2004 (Table 1). The above agrees with what Sanchez-Garcia et al. (2015) who indicates that in the wheat flour mass, strong and extensible masses, ie low PL values, must be conjugated to favor the volume of bread.

GENOTIPO	DG	R	W	R	PL	R	VP	R
BACOREHUIS F2015	46	50-41	319	425-253	1.0	1.5-0.7	789	830-745
CONATRIGO F2015	46	52-40	381	514-278	1.0	1.6-0.5	847	920-755
Línea 1	52	53-50	211	250-180	0.8	1.1-0.4	830	895-805
Línea 2	47	52-41	322	430-230	1.9	2.1-1.2	720	750-730
Línea 3	46	52-40	289	300-230	1.3	2.0-0.9	765	800-700
BORLAUG 100	46	48-44	334	445-263	1.0	1.6-0.5	840	890-800
VILLA JUAREZ F2009	42	47-38	342	488-237	1.3	2.2-0.8	734	745-720
ROELFS F2007	45	46-43	364	467-247	1.0	1.9-0.5	787	800-770
KRONSTAD F2004	40	45-36	426	550-300	1.0	1.3-0.7	827	855-790

DG = grain hardness (%); W = force of mass (10-4 J); PL = tenacity / extensibility ratio (0-7); VP = volume of bread (ml). R = rank.

Table 1 Mean and range of industrial quality variables of controls, new varieties and candidate lines for irrigated wheat in Mexico.

All genotypes analyzed under time were classified with hard grain, which is desirable since it will avoid germination in the spike when there is presence of rain at its maturity as indicated by Dencic et al. (2013).

The genotypes Valles F2015, line 2, line 3 and ALTIPLANO F2007 were characterized by having strong average masses based on their W of 200 to 300. TLAXCALA F2000 and line 2 presented strong mass, for its W> 300, contrary to what was shown By DON CARLOS F2015 who presented the lowest value of force, W <200, however, due to its extensibility, I presented acceptable bread volume values. Based on its PL, VALLES F2015, it was classified as extendable mass as line 2 and control varieties, TLAXCALA F2000 and ALTIPLANO F2007. Line 1 and 3 presented balanced masses, with less extensibility, so that these genotypes obtained the smaller volumes of bread, contrary to the rest of the genotypes, which associated strong or strong medium masses with excellent extensibility, PL value <0.9, and Presented volumes of bread larger than 800 ml, (Table 2).

Genotipo	DG	R	W	R	PL	R	VP	R
Don carlos f2015	41	44-38	192	233-158	0.6	0.8-0.4	806	860-760
Valles f2015	39	42-36	272	316-239	0.7	0.8-0.6	813	880-760
Línea 1	35	36-34	239	266-212	1.2	1.1-1.2	748	775-720
Línea 2	40	42-37	324	355-280	0.6	0.9-0.4	871	955-790
Línea 3	42	46-38	242	267-217	1.1	1.3-0.9	733	760-705
Altiplano f2007	40	42-38	290	326-231	0.7	0.9-0.5	870	975-775
Tlaxcala f2000	38	41-36	369	397-340	0.8	1.0-0.7	874	930-840

DG = grain hardness (%); W = force of mass (10-4J); PL = tenacity / extensibility ratio (0-7); VP = volume of bread (ml); R = Range.

Table 2 Mean and range of industrial quality variables of controls and candidate lines for temporary wheat in Mexico.

Conclusions

The new irrigation varieties BACOREHUIS F2015 and CONATRIGO F2015 as well as the experimental line ND643 / 2 * WBLL1 // MUNAL / 3 / MUNAL # 1 presented characteristics of grain hardness and mass strength appropriate for the national baking industry. Same behavior showed DON CARLOS F2015, VALLES F2015 and the advanced line GAVIA / ROM / 3 / PIRUL / GUI / TEMP / AGR / 4 / JUCH, which are suitable for temporary production. So its use can contribute to obtain the quality of the harvest demand by the national milling industry.

Aknowledgement

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Article **ECORFAN-Ecuador Journal**

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Use of *Spirulina maxima* algae as a prebiotic additive in chicken for fattening and its nutraceuticals effects on the intestinal integrity and antimicrobial effect vs *Salmonella spp*

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Resumen

Se estudiaron las algas Spirulina maxima como aditivo prebiótico en el pollo para engorde, y sus efectos nutracéuticos sobre la inmunidad y la integridad intestinal. Se emplearon 300 pollos (línea Cobb, edad un día) con 5 tratamientos bajo un diseño de bloques completos al azar. Cada tratamiento consistió en 5 repeticiones de 12 aves por grupo, un total de 60 unidades experimentales por tratamiento, en corrales separados con vigilancia, temperatura: ponderación a los 21, 35 y 49 días de edad. Sobre la base de recomendaciones nutricionales, las dietas experimentales fueron Isoenergéticas e isoproteicas. En los datos obtenidos se observó que tanto el aumento de peso semanal con incorporación de aditivos en la dieta como en el consumo semanal y la conversión alimenticia, los cinco tratamientos utilizados tienen el mismo grado de efectividad. En la integridad intestinal observamos el comportamiento de los cinco parámetros a 42 días, lo que indica que el antibiótico confería mayor integridad intestinal. Los prebióticos, probióticos y simbióticos mantienen el mismo nivel de efectividad en el desarrollo de la longitud y el grosor de las vellosidades, las criptas y la generación de la mucosa. Los resultados del análisis bacteriológico a los 21 y 42 días en 5 tratamientos no mostraron en ninguna ave, el crecimiento de Salmonella spp. Significativa, sólo se encontraron en el tratamiento de control a 21 días.

Prebióticos; Trato gastrointestinal (GIT); Los promotores del crecimiento de antibióticos (APC)

Abstract

We studied *Spirulina maxima* algae as a prebiotic additive in chicken for fattening, and its nutraceuticals effects on immunity and intestinal integrity. We employed 300 chickens (line Cobb, age one day) with 5 treatments under a randomized complete block design. Each treatment consisted of 5 repetitions of 12 birds per group, a total of 60 experimental units by treatment, in separate pens with monitored, temperature: weighting at 21, 35 and 49 days of age. Based on nutritional recommendations, experimental diets were Isoenergetic and isoproteic. In the data obtained we observed that both weight gain weekly with incorporation of additives in diet, and in the weekly consumption and feed conversion, the five treatments used have the same degree of effectiveness. In intestinal integrity we observed the behavior of the five parameters to 42 days, indicating that the antibiotic conferred greater intestinal integrity. Prebiotics, probiotics and symbiotics maintain same level of effectiveness in development of the length and thickness of villi, crypts and generation of mucosa. Results of bacteriological analysis at 21 and 42 days in 5 treatments did not show in any bird, growth of Salmonella spp. significant, were only found in control treatment to 21 days.

Prebiotics; Gastrointestinal tract (GIT); Antibiotics growth promoters (APC)

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Introduction

Global meat production, projected at moderate growth, is expected to be at the rate of 1.6% per year over the next decade. In this context, poultry meat will continue to be the leader in the animal protein complex, maintaining its status as the most affordable and affordable source of meat protein, maintaining more stable prices, (OECD / FAO / UACh, 2013). At present, it is essential for the poultry industry to adopt biosecurity standards in their production systems, moving from the direct mortality rate as an economic indicator, to losses due to low productivity, typical of animal health problems. In meat poultry intestinal affections caused by enteric diseases, generate the greater economic loss of the subsector, compromising the transformation of nutrients. Therefore, the aim of promoting a good development and optimum state of the gastrointestinal tract (GIT) are substantial elements. (Barragán, 2012).

(TGI) is a complex tubular organ, covered by specialized epithelial cells that perform two primary functions: 1) provide microbial protection, and 2) digestion and absorption of nutrients. Such functions may be affected by dysbacteriosis, and from this point of view the action of the additives commonly used in animal feed is clear. Under this term include auxiliary substances as diverse as: supplements, medicines, growth promoters, etc. Within the latter group we find the growth promoting antibiotics (APC), which cause digestive and metabolic changes in the animals that translate into an improvement of nutritional efficiency, also reducing the incidence of diseases. However, the use of APC in animal nutrition has been banned in some parts of the world, based essentially on the danger of these substances to generate cross-resistance with the antibiotics used in human media (Carro and Ranilla, 2002).

In general, two alternatives to APC use can be considered: a) the implementation of new management strategies and b) the use of other substances that have effects similar to those of the CPAs on the productive levels of the animals. Among the main alternative additives are probiotics, prebiotics, organic acids, enzymes, and plant extracts called functional foods (Carro y Ranilla, 2002). The so-called functional foods produce beneficial effects, superior to those of traditional foods. Prebiotics are non-digestible dietary ingredients that stimulate the growth or activity of one or more types of bacteria in the colon. Probiotics are living microorganisms that, when added as a dietary supplement, favor the development of normal microbial flora in the intestine. Symbiotics combine in their formulations the union of prebiotics and probiotics, which allows to take more advantage of the benefits of that union. (Cagigas Reig 2001). The present biotechnology development offers various nutraceutical elements for humans as well as for animals, microalgae biomass is characterized by its protein richness (60-70%), good content of amino acids and essential fatty acids, antioxidant pigments, carbohydrates, vitamins, minerals, Etc., which due to its chemical structure renders it indigestible by the TGI, thus offering an excellent additive for the bifidobacteria present therein (García, 2012). In this area we find the Spirulina maximum microalgae of great commercial impact, which in humans is attributed nutritional properties with direct benefits in intestinal health and immune system, due to its prebiotic and biostimulating effects.

Likewise, the search for these effects in animals has more frequently favored its use in animal nutrition as a nutraceutical additive, which, because of its chemical structure, makes it a prebiotic.

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The objective of the present work was to evaluate the nutraceutical effect of the Spirulina maximum microalgae as a prebiotic in the feeding of the broiler chicken, determining the impact of this on the productive parameters and integrity of the TGI.

Materials and methods

The present work was carried out in the poultry area belonging to the Department of Animal Production of the University Center of Biological and Agricultural Sciences (CUCBA) of the University of Guadalajara, employing 300 chickens from the Cobb line of a day of age and distributed in an experimental design Of randomized complete blocks with 5 treatments (T):

T1. Witness (commercial food without additives)

T2. T1 + APC (antibiotic Bacitracin 150 g / t)

T3. T1 + Probiotic (Saccharomyces cerevisiae cell
walls 2 kg / t)

T4. T1 + Prebiotic (Spirulina maximum 2 kg / t)

T5. T1 + Symbiotic (Spirulina maximus + Saccharomyces cerevisiae cell walls 2 kg / t)
Each treatment consisted of 5 replicates of 12 birds per group, obtaining a total of 60 experimental units per treatment, which were placed in independent pens with monitored temperature. The groups were submitted to a previous vaccination program. Food and water were supplied daily for free for a period of 49 days. The animals were weighed at 21, 35 and 49 days of age.

The diet was considered based on the nutritional recommendations being the experimental diets isoenergetic and isoproteic.

The variables evaluated were: 1) for productive parameters: feed intake (g / bird / week), body weight (g / bird / week), weight gain), Feed conversion (AC) (CA / bird / week); And in 2) histological parameters: intestinal villi size and crypt length (mm / at 21 and 42 days) at jejunum level; As well as: microbiological analysis of GIT at the level of the blind.

At the end of the test period, 10 animals were selected per treatment, which were sacrificed to obtain the small intestine, taking jejunum and ileum samples to determine the intestinal integrity variables. In order to corroborate in the treatments the antimicrobial effect, with respect to Salmonella spp, a strain of Salmonella typhimurium ATCC 14028 was used as positive control and confirming results by means of PCR test.

Estadistical analisis

The results were subjected to an analysis of variance using an appropriate statistical package (Minitab), and Tukey's test ($p \leq 0.05$) was used for the variables that presented statistical difference, for the separation of means.

Results

Food efficiency

During the evaluation period, a linear increase in the body weight of the birds was observed for all treatments (Table 1), although T1 had a significant difference ($P \leq 0.05$) of the highest initial weight over the rest in the final no was statistically different.

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VARIABLES	TREATMENTS				
	WITNESS	PREBIOTIC	SYMBIOTIC	ANTIBIOTIC	PROBIOTIC
Initial weight, g / chicken (7 days old)	172 [a]±.018	159 [b]±.017	160 [a,b]±.019	165 [a]±.020	160 [b]±.021
Final weight, kg / chicken	2.410±.22	2.38±.26	2..350±.23	2.330±.95	2.320±.25
Total weight gain, kg / chicken	2.238.±.23	2.228±.26	2.197±.23	2.165±.29	2.159±.25
Total feed consumption, kg / chicken	4.266 [a]±.34	4.172 [b]±.44	4.030.30 [b]±.37	3.980 [b]±.33	3.994. [b]±.32
Food Conversion	1.90	1.87	1.83	1.81	1.84

Table 1 Productive parameters in chickens for fattening due to the treatments used in feeding for 42 days

Intestinal integrity

In tables 2 and 3 we observed how the generation of the mucosa at 21 days the highest value was the antibiotic treatment and the lowest the prebiotic treatment, however at 42 days it was observed that the latter was the highest value. In the crypt length at both 21 and 42 days the highest value was that of the antibiotic, followed by the prebiotic. In the length and thickness of the villi, at 21 days the values of the control and antibiotic treatment were statistically different P <0.05 with respect to the other three treatments.

sampling	ng Mucosa	ng Mucosa	ng Mucosa	ng Mucosa
tness	07.51 84	3.9 16.04	05.58 [a]±185.6	1.23 [a]±18
tibiotic	57.78 50	3.29 58.61	78.96 [b]±159.1	.64 [a]±16
biotics	37.17 80	2.7 41.70	04.47± [c]101.7	2.48 [b]±21
biotics	63.29 19	5.3 .6.35	00.3 [c]±121.3	.99 [b]±16
mbiotic	01.48 31	4.45 23.19	96.11 [c]±128.7	.48 [b]±17

*** Different literals show statistically significant difference p = <0.05**

Table 2 Intestinal integrity 21 days (μm)

Table 3 shows the measurements of intestinal integrity and indicate that the antibiotic conferred greater intestinal integrity. However, both prebiotics, probiotics and symbiotics maintain the same level of effectiveness in the development of villi length and thickness, Crypt length and mucosal generation.

d sampling	ng ucosa	ng ucosa	ng ucosa	ng ucosa	ng ucosa
tness	stigo	13.91 8	.37 20.29	15.53 [a] 95.3	6.37 6.45
tibiotic	tibiótico	56.95 36	4.39 4.10	12.55 .48	2.24 .7.71
biotics	biótico	11.08 11	0.96 2.58	80.12 [a] 109.5	1.62 3.30
biotics	biótico	18.78 979	4.37 5.37	78.35 .25.7	3.58 6.25
mbiotic	nbiótico	01.12 65	7.01 1.44[a]	64.1 245.6	4.49 5.09

* Different literals show statistically significant difference p = <0.05

Table 3 Intestinal integrity 42 days (μm)

Bacterial growth

The results of bacteriological analysis of birds at 21 and 42 days in all treatments did not show any significant Salmonella spp growth.

In the study, Salmonella spp was not isolated in any of the birds; they were only found in the control treatment at 21 days (Table 4).

Treatment	Isolated strain	21 days	42 days
Witness	Salmonella spp	+	-
Antibiotic	Salmonella spp	-	-
Prebiotic	Salmonella spp	-	-
Probiotic	Salmonella spp	-	-
Simbiótico	*Salmonella spp*	-	-

Table 4 Antimicrobial effect for Salmonella spp In TGI of broilers at 21 and 42 days of age, derived from the inclusion of feed additives

Discussion

Maintaining intestinal integrity allows optimal intestinal functionality, where proper maintenance of the intestine will result in uniform and efficient bird growth.

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Any aggression of the intestine in the chicken is answered from the digestive tract, diverting energy that should be destined for meat replenishment, and defensive function (Faus, 2008). For this reason, a healthy digestive tract is required, with its associated balanced microbial population, and adequate digestive enzymatic secretions, which is essential to obtain a good performance according to the genetic potential of the chicken (Boy, 2013).

In our study, the use of Spirulina algae maximal as a prebiotic, we sought to reflect an early complete and complete development of the gastrointestinal tract, which allows to optimize a digestion and absorption of nutrients and consequently the growth rate and the feed conversion index, The values of weight gain found in our study, coincided with Bezares et al. (1976) who in 28 days of experimentation with Spirulina geitleri, found that chick weight gain was similar for diets with two levels of spirulina, and when pigmentation was evaluated, this increased as the level of pigmentation increased. Spirulina in diets; Being greater this effect in the birds that received spirulina all his life, Bezares et al. Recommend a dose of no more than 5% spirulina in broiler diets, which provides good pigmentation and has no adverse effects on weight gain or feed conversion. They coincide with Márquez et al. (1974), who found that diets with high levels of spirulina reduce the growth of chickens. In the case of this study, inclusion levels were low, 0.2%. In addition, the spirulina algae have been shown to be a good source of xanthophylls for egg yolk pigmentation (Gutton, 1970; Ávila and Cuca, 1974; Bezares et al., 1976; Silerio et al. Of egg, tarsi and skin of chickens for fattening. However, in studies with chickens, Márquez et al. (1974) observe only a slight response to lysine supplementation and conclude that only small amounts of soybean paste can be substituted for spirulina with no effect on growth.

Regarding the use of prebiotics in birds, Blanch (2015), cites references of the 4 works made by the following authors: 1) Baurhoo et al. (2009) where they indicate that mainly, prebiotics seem to selectively improve the populations of lactobacilli and bifidobacteria and reduce colonization by pathogenic bacteria. Most of the prebiotics currently used in animal feed are carbohydrates and oligosaccharides with different molecular structures. 2) (Biggs and Parsons, 2008). Yurizal and Chen (2003) mention that supplementation of fructans in the diet resulted in an increase in lactobacillus counts in the GIT and a decrease in Campylobacter and Salmonella. 3) Also, Spring et al. (2000) indicated that the yeast cell wall rich in Mannanoligosaccharides (MOS) reduced by 26% the intestinal concentrations of Salmonella in broilers. 4) Similarly, in a subsequent study (Jung et al., 2008) with a standard diet and galactooligosaccharides (GOS) at two different concentrations, they clearly observed a significant increase in bifidobacteria populations in the gut. Coinciding with the previous work in our study and according to the results obtained from the bacteriological analysis of the birds at 21 and 42 days in all treatments did not show any significant growth of Salmonella spp were only found in the control treatment at 21 Days, and to the components and nutritional properties of Spirulina maximum algae, allow us to consider that it is a good prebiotic additive, based on its cellular structure (plasma membranes), which make them an indigestible element by (TGI) Thus an excellent nutraceutical additive for the bifidobacteria present there, without side effects that affect the consumer of the bird as it is the case of the use of APC. In this way it is favored that the TGI of the chicken multiplies its defense mechanisms nonspecific and immunological increasing the rate of growth and the feed conversion.

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Conclusions

It is determined that both the weekly weight gain as the weekly consumption and the feed conversion, in the five treatments used have the same degree of effectiveness.

It is observed that the behavior of the five parameters at 42 days and the measurements indicate that the antibiotic (Bacitracin) conferred a greater intestinal integrity, however both the Prebiotic (alga Spirulina maximum), Probiotic (cell walls of Saccharomyces cerevisiae) and Symbiotic (Spirulina maximus + cell walls of Saccharomyces cerevisiae) maintain the same level of effectiveness in the development of the length and thickness of villi, crypt length and mucosa generation.

The results of bacteriological analysis of chickens at 21 and 42 days in all treatments showed no significant growth of Salmonella spp. In the study, Salmonella spp was not isolated in any of the study birds; they were only found in the control treatment at 21 days.

Concluding that the maximum Spirulina algae, represents an excellent alternative as a prebiotic additive, for the bifidobacteria present there, favors that the chicken TGI multiply its defense mechanisms and its immunological factor, increasing the speed of growth and nutritional conversion, without side effects that Affect the consumer of the chicken. It also has advantages such as reproducing quickly (doubling its biomass in 4-5 days) in shallow ponds, and nowadays in the world are growing less and less costly.

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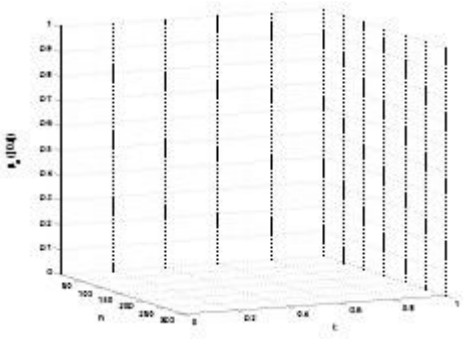

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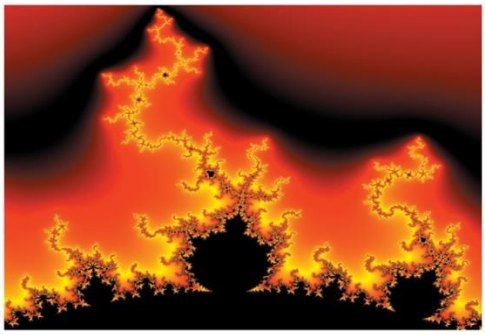

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Conclusions

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References

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