Influencia de las variedades de maíz (Zea mays L.) de Campeche (México) sobre la ganancia de peso en ratones

Influence of the maize varieties Zea mays L. of Campeche on the weight gain in mice

Influência de variedades de milho (Zea mays L.) Campeche (México) sobre o ganho de peso em ratinhos

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Resumen

El objetivo de este estudio fue evaluar el efecto de los extractos de cinco variedades de maíz cultivados en el Estado de Campeche (México) sobre el aumento del peso corporal y la cantidad de alimentos consumidos por ratones albinos machos. Se monitoreó la cantidad de agua bebida, la cantidad de alimento ingerido y el peso corporal de los ratones; tanto el consumo de agua y de alimentos no variaron en los diferentes grupos del estudio, pero el peso corporal ganado por los ratones alimentados con una dieta alta en grasas y tratados con extracto de maíz morado fue significativamente menor (36.32 %) en comparación con el grupo control (48.5 %). Este efecto fue más notorio a partir de la quinta semana del tratamiento, cuando el porcentaje de incremento de peso aumentó más pronunciadamente en los grupos controles.

Palabras clave: obesidad, alimentación, fitoquímicos.

Abstract

The objective of this study was to evaluate the effect of the extracts of five varieties of corn grown in the State of Campeche (Mexico) on the increase of body weight and the amount of food consumed by mice albino male. The amount of drink water, the amount of food ingested and the body weight of the mice were monitored; both water and food consumption did not vary in the different study groups, but the body weight gained by mice fed a diet high in fats and treated with purple corn extract was significantly lower (36.32%) compared with the control group (48.5%). This effect was most noticeable from the fifth week of treatment, when the percentage of weight gain increased more sharply in the control groups.

Key words: obesity, nutrition, phytochemicals.

Resumo

O objetivo deste estudo foi avaliar o efeito de extratos de cinco variedades de milho cultivadas no estado de Campeche (México), em aumento do peso corporal e da quantidade de ratos albinos machos de alimentos consumidos. a quantidade de monitoramento beber água, a ingestão de alimentos eo peso corporal de ratos; tanto de água potável e de alimentos não variou nos diferentes grupos de estudo, mas o peso corporal adquirida por aqueles alimentados com uma dieta rica em gordura e tratada com ratos extrato de milho roxo foi significativamente menor (36,32%) em comparação com o grupo de controlo (48,5%). Este efeito foi mais perceptível a partir da quinta semana de tratamento, quando a percentagem de ganho de peso aumentou mais acentuadamente nos grupos de controle.

Palavras-chave: obesidade, nutrição, fitoquímicos.

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Introduction

Obesity is a chronic metabolic disorder and although this can have multiple causes its origin is the imbalance between energy consumed and the energy spent, this imbalance causes an excessive accumulation of fat, mainly in adipose tissue, liver, and skeletal muscle, which represents a risk to health (Adnyana et al., 2014. El-nahas et al., 2014.

Manjula et al., 2014. Yuniarto et al., 2015). Obesity is a global public health problem as it is one of the main causes that contribute to the development of metabolic disorders such as type 2 diabetes, hypertension and cardiovascular diseases (Ahmed et al., 2009. Adnyana et al., 2014. Yuniarto et al., 2015).

Now changes in the lifestyles of humans generate the need to consume high-calorie foods, thus favouring the increase in the prevalence of obesity. Although there are drugs that are used in the treatment of obesity and disorders in the metabolism of carbohydrates and lipids, they present different adverse effects which limit its use, so the treatment of obesity with natural products as an alternative to allopathic drugs is promoted (Attele et al., 2002. Lemhadri et al., 2007. Adnyana et al., 2014. El-nahas et al., 2014). In addition, treatment of obesity should be comprehensive and include - along with the drug therapy - exercise, a balanced and healthy diet, lifestyle changes and behavioral therapy, in this sense, the consumption of vegetables that contain phytochemicals like polyphenols, anthocyanins and flavonoids help to improve the health of the individual because they have antioxidant, anti-inflammatory and modulate the metabolism of carbohydrates and lipids (Ahmed et al., 2009. Adnyana et al., 2014. Lee et al., 2014. Manjula et al., 2014. Zaman et al., 2015).

Varieties of corn are rich source of phytochemicals with potential beneficial effects on consumer, also maize is the staple food of the peoples of Latin America, where it is constantly consumed in various foods and beverages (López-Martínez and García-Galindo, 2009. Castañeda-Sánchez, 2011. Salinas Moreno et al., 2012. Serna Saldívar et al., 2013). Therefore the aim of this study was to evaluate the influence of the consumption of maize varieties in Campeche (Mexico) on weight gain in mice fed with three different types of diets (balanced, fat and corn-based).

Methodology

The maize samples used in this study were collected in the municipality of Hopelchén (Campeche, Mexico); Five maize varieties were obtained: four criollas (white, yellow, red and purple) and one hybrid (white). The samples were identified at the Autonomous University of Campeche and later taken to the laboratory for processing; First the

impurities and foreign matter that contained the ears were removed and soon they were shredded by hand; The grains were ground and the flours obtained were stored in dry plastic containers; A portion of the flours were milled with 70% aqueous ethanol for 24 hours at room temperature, the extracts were concentrated to dryness (first on a rotary evaporator equipped with a water bath at 40 ° C. for the removal of the ethanol and then in a lyophilizer at 13.3 Pa For 72 h); These extracts were preserved in amber vials until their use.

In this study, 10-week-old male albino (Mus musculus) mice weighing more than 20g and pre-conditioned for one week, maintained at 30 ° C and 50% relative humidity were used with water and purine feed ad libitum , With light-dark cycles of 12 hours. Following the standard indications of caregivers and mouse growers and the instructions of Official Mexican Standard NOM-062-ZOO-1999 that dictates the technical specifications for the reproduction, care and use of laboratory animals. The animals were randomly divided into groups of six individuals; Each group was given a specific diet for 60 days: in the first experiment, balanced feed (purine ®); In the second fatty food (mixing balanced food with refined foods high in sugar, triglycerides and cholesterol); In the third, corn flour (in the form of dough, as sole source of food). For the first two experiments the negative control group was given NaCl saline solution 0.85% and each maize extract subcutaneously injected at a dose of 250 mg / kg for the duration of the experiment. In the corn-based diet experiment the group fed with balanced feed was used as control and each problem group was fed with the respective maize flour. The weight of each individual was monitored weekly.

Measurement of food consumption by mice was determined by placing each mouse in individual cages after an 18h fast, but with free access to water, 5.0 grams of food was placed 30 minutes after administration of the extract and after one Hour the food was replaced with another 5.0 grams of food; The consumption by difference between the initial weight of food deposited and the final weight after a period of five hours was determined; This procedure was evaluated for seven days. Water consumption was determined individually by directly measuring the amount of drinking water per mouse using a drinking fountain.

Statistic analysis

Statgraphics plus 5.1 ® was used to analyze the results of the tests for an exploratory examination; the descriptive statistics with which the values are reported are the mean and a standard deviation; The results of each bioassay were analyzed to find significant statistical differences among the maize varieties evaluated in each treatment by a one - way ANOVA followed by a multiple range test using the multiple comparison method Tukey's means by the least significant difference LSD procedure, with a confidence level of 95% (= 0.05).

Results and Discussion

Tables 1, 2 and 3 report the results of monitoring daily consumption of food and water ingested by the mice in each treatment. The consumption of water and food did not show significant intergroup differences; But the percentage of weight gain did: mice fed with balanced meal and treated with extracts of red and purple maize showed a lower weight gain compared to the rest of the groups, the group treated with yellow maize extract was the one that Had the highest increase but did not differ statistically with those treated with white maize extract or with the control group.

Table 1. Amount of water and food ingested and percentage of increase in weight from the beginning to the eighth week of treatment with diet of balanced feed.

Extracto	Alimento ingerido (g/día)	Agua ingerida (mL/día)	% Aumento peso
Morado	3.45±0.26^{a}	3.5±0.6^{a}	33.6±1.1^{a}
Rojo	3.64±0.22^{a}	3.6±0.5^{a}	32.8±1.4^{a}
Amarillo	3.62±0.24^{a}	3.2±0.4^{a}	37.7±1.3^{b}
Blanco Criollo	3.59±0.31^{a}	3.5±0.6^{a}	36.0±1.3^{b}
Híbrido Blanco	3.86±0.23^{a}	3.9±0.6^{a}	36.3±1.2^{b}
Solución salina	3.36±0.26^{a}	3.8±0.5^{a}	35.9±1.3^{b}

Results expressed as X ± SD, different letters in the same column indicate significant differences. Source: Database of the Study of Maize Varieties of Campeche, UACam.

This same tendency was observed, although with a greater differentiation in the groups fed with food fat high. With the exception of the group treated with yellow maize extract that gained less weight than the groups treated with white maize extract and the control group,

this effect may be due to the fact that yellow corn contains vegetable fats that favor weight gain in A balanced diet but on a fat diet could inhibit the absorption of animal fats such as cholesterol (Suneetha et al., 2013. Bais et al., 2014. Sharma et al., 2014. Ezekwesili-ofili and Gwacham, 2015). In diets the high percentage of fats is a determining factor and important in the development of obesity because it causes an accumulation of fat in the tissues, even when the caloric intake is equal to another balanced diet (Sharma et al., 2014. Ezekwesili-ofili y Gwacham, 2015).

Table 2. Amount of water and food ingested and percentage of increase in weight from the beginning to the eighth week of treatment with diet of fatty food.

Extracto	Alimento ingerido	Agua ingerida	% Aumento peso
Morado	2.84±0.16^{a}	3.1±0.5^{a}	36.32±1.0^{a}
Rojo	2.95±0.14^{a}	3.2±0.4^{a}	39.6±1.3^{a}
Amarillo	2.91±0.16^{a}	3.0±0.4^{a}	43.6±1.3^{b}
Blanco Criollo	2.98±0.18^{a}	2.9±0.4^{a}	47.8±1.6^{c}
Híbrido Blanco	3.05±0.19^{a}	2.6±0.4^{a}	46.0±1.2^{c}
Solución Salina	3.07±0.16^{a}	2.9±0.3^{a}	48.5±1.4^{c}

Results expressed as X ± SD, different letters in the same column indicate significant differences. Source: Database of the Study of Maize Varieties of Campeche, UACam.

The results of the corn meal fed groups show that the mice consumed slightly less than when the balanced or fatty feed was supplied, possibly due to palatability; The amount of drinking water was similar to that of the other groups. The percentage of weight gained was similar in all groups fed corn meal, but less than the group fed with balanced feed; The flour used in food is a whole grain cereal that does not lose the nutrients contained in the grain, such as aleurone, and provide beneficial vitamins, minerals and phytochemicals such as lignans and other phytoestrogens with anticancer and cardioprotective properties (Castañeda Sánchez, 2011. Salinas Moreno et al., 2012. Serna Saldívar et al., 2013. Ezekwesili-ofili y Gwacham, 2015).

Table 3. Amount of water and food ingested and percentage of increase in weight from the beginning to the eighth week of treatment with maize diet.

Alimento	Alimento ingerido	Agua ingerida	% Aumento peso
Morado	2.51±0.26[a]	3.8±0.5[a]	24.6±1.4[a]
Rojo	2.69±0.22[a]	3.3±0.4[a]	25.15±1.0[a,b]
Amarillo	2.84±0.24[a]	3.1±0.4[a]	27.7±1.2[b,c]
Blanco	2.78±0.31[a]	3.7±0.5[a]	28.1±1.5[b]
Híbrido	2.81±0.23[a]	3.6±0.5[a]	26.2±1.6[a,b]
Purina ®	3.36±0.26[b]	3.8±0.5[a]	35.9±1.3[c]

Results expressed as X ± SD, different letters in the same column indicate significant differences. Source: Database of the Study of Maize Varieties of Campeche, UACam.

When comparing the percentages of weight gained at the end of the experiment in each treatment, the information in figure 1 was obtained, where it can be seen that the extract maize purple decreased weight gain in the mice treated with it, particularly with the fed With the diet high in fat; The results obtained in the mice treated with the extract of purple maize were similar to those fed the balanced diet. Extracts of red and yellow maize exerted less weight gain inhibitory activity compared to the maize extract but significant compared to the control groups (fat and feed). Animal models of obesity are used to resemble human obesity for the purpose of finding metabolites that are used in treatments effective for reducing body weight (Nukitrangsan et al., 2012). Adnyana et al., 2014. Sharma et al. 2014. Ezekwesili-ofili and Gwacham, 2015).

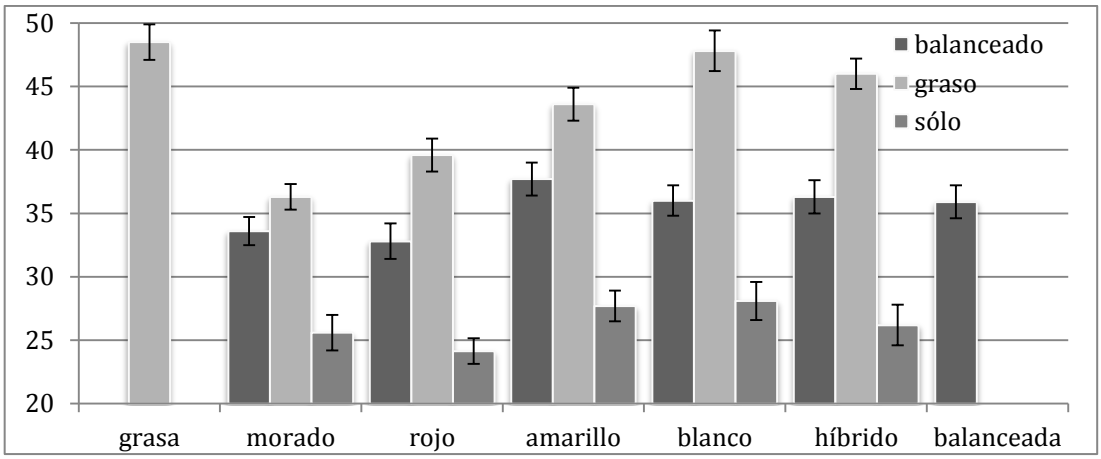

Figure 1. Percentage of weight gained at the end of dietary treatment by all experimental groups. Source: Database of the Study of Maize Varieties of Campeche, UACam.

The graphs of weekly weight variation are shown in Figures 2, 3 and 4. In the different diets evaluated, the main variation was in the percentage of weight gained at the end of the experiment; The weight behavior in all individuals fed with balanced feed was similar and no significant effect was observed.

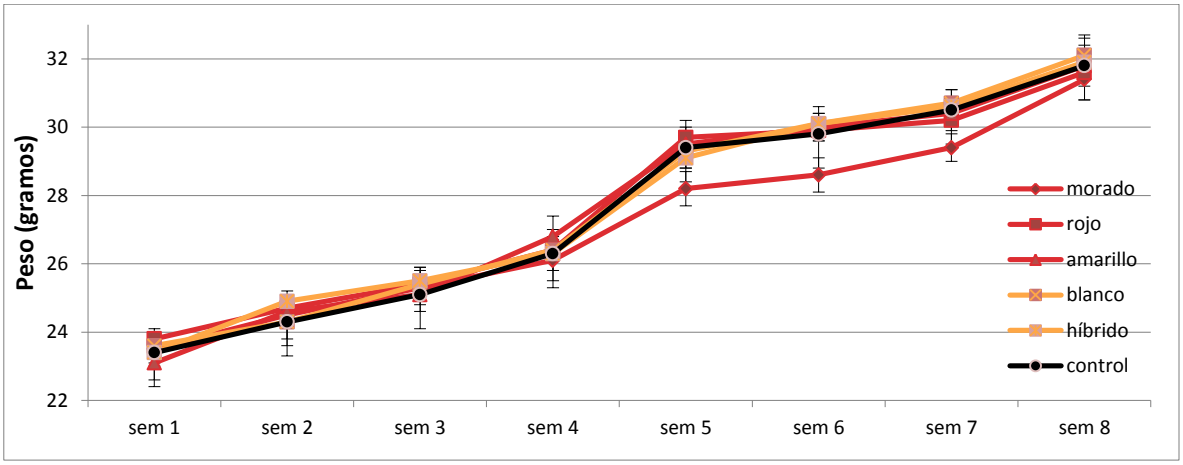

Figure 2. Weekly variation of the weight of mice fed a balanced diet. Source: Database of the Study of Maize Varieties of Campeche, UACam.

In individuals fed a high fat diet initially the behavior of the weight parameter is similar in almost all cases, but at the fifth week there is a differentiation in weight gain; In this period the increase of the control group is greater than in the other groups and the group treated with extract of purple maize begins to have a lower slope than the rest of the treatments.

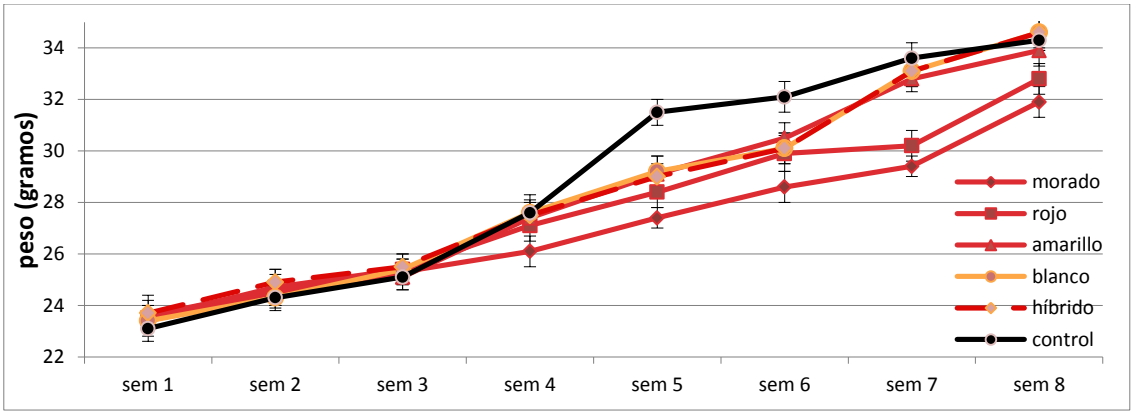

Figure 3. Weekly variation of the weight of mice fed a high fat diet. Source: Database of the Study of Maize Varieties of Campeche, UACam.

In the groups fed whole maize meal, the weight gain was lower compared to the group fed a balanced diet. In part this is due to the fact that the amount (by weight) of the meal consumed was lower in comparison with the balanced feed consumed.

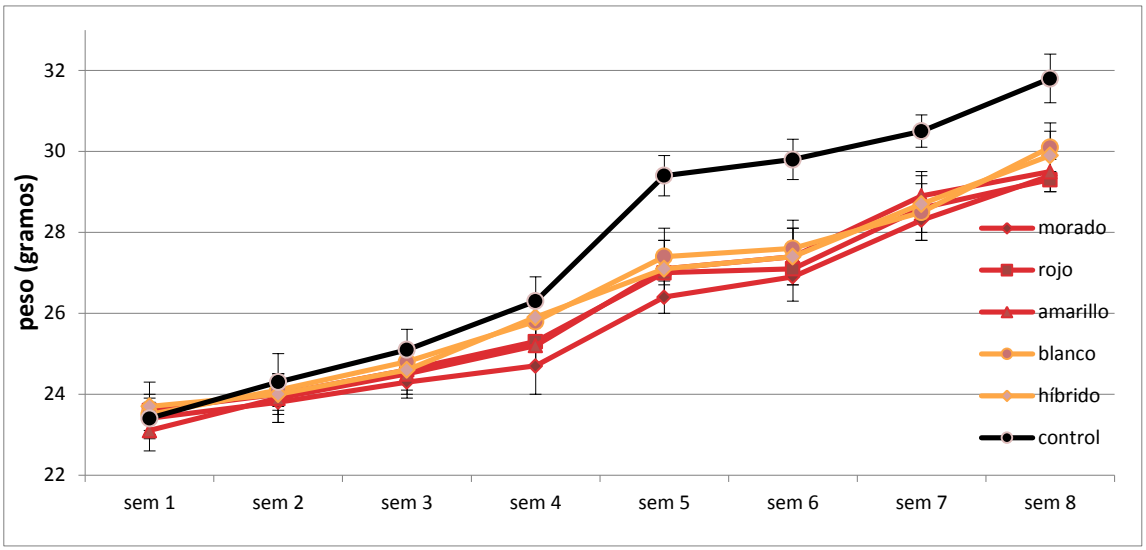

Figure 4. Weekly variation of the weight of mice fed corn meal. Source: Database of the Study of Maize Varieties of Campeche, UACam.

Due to the perceived propensity that treatments with purple maize tended to decrease weight gain in mice, it was decided to draw the graph of Figure 5 to better appreciate this trend by comparing the groups treated with purple maize against the control groups Balanced diet and fat.

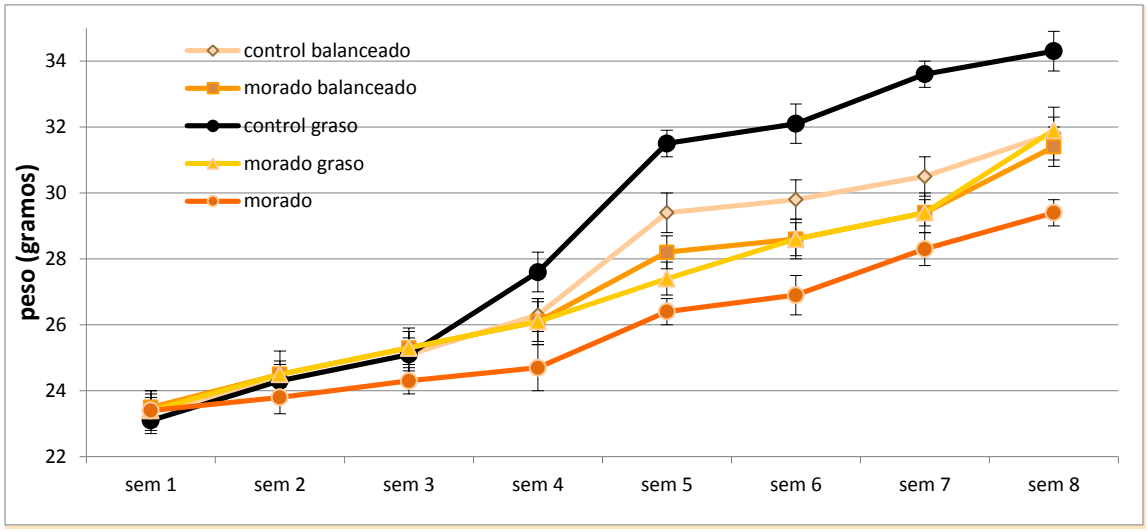

Figure 5. Weekly variation of the weight of the mice treated with purple corn. Source: Database of the Study of Maize Varieties of Campeche, UACam.

Increased body weight is a consequence of a metabolic disorder that leads to obesity; Increasing the calories eaten and not increasing the energy expenditure with physical activity promotes the onset of obesity (Adnyana et al., 2014. Ezekwesili-ofili and Gwacham, 2015. Naowaboot and Wannasiri, 2016). A common measure to combat obesity is the reduction of food, however, maize extracts did not reduce the consumption of food, which is why the percentage decrease in weight gain is due to other factors, possibly because the secondary metabolites present in The extracts inhibit enzymes involved in the metabolism of carbohydrates or lipids, either to avoid their absorption or assimilation or to favor their energy consumption (Attele et al., 2002. Zhang et al., 2008). Ahmed et al., 2009. Naowaboot y Wannasiri, 2016).

The induction of obesity by a diet rich in carbohydrates and fats is one of the simplest and possibly the most similar models with the development of obesity in humans; The consumption of a high-calorie food leads to increased fat storage which in turn leads to increased body weight (Nukitrangsan et al., 2012). Ezekwesili-ofili and Gwacham, 2015. Yuniarto et al., 2015). Similarly, obesity generated by a diet rich in fats leads to insulin resistance that causes a decrease in the ability of insulin to regulate glucose metabolism in peripheral tissues; There is a wealth of scientific information demonstrating the association between obesity and imbalance in glucose metabolism, especially with insulin homeostasis (Lemhadri et al., 2007. Ezekwesili-ofili y Gwacham, 2015. Naowaboot y Wannasiri, 2016).

Maize contains various phytochemicals known as nutraceuticals because they have positive health activities for those who consume it in their diet; The phytochemical composition of the maize grain depends on the variety considered since there is a genotypic and phenotypic variation of maize; In this aspect, the Creole maize represents an attractive option due to its great phytochemical diversity (López-Martínez and García-Galindo, 2009. Castañeda-Sánchez, 2011. Salinas Moreno et al., 2012 Serna Saldívar et al., 2013). All maize contains simple phenolic compounds, but only pigmented maize such as blue or purple contains significant amounts of anthocyanins, compounds which exert various biological activities as antioxidants, antibiotics, lipid-lowering agents; In addition corn contains dietary fiber and phytosterols that help the formation of feces and decrease plasma levels of lipids preventing cardiovascular accidents; Also contains pigments such as carotenoids and xanthophylls with antioxidant properties and precursors of other substances of biological

interest such as vitamin A (Ahmed et al., 2009). Castañeda-Sánchez, 2011. Salinas Moreno et al., 2012 Serna Saldívar et al. . 2013. Suneetha et al., 2013. Bais et al., 2014. Lee et al., 2014. Zaman et al., 2015). Maize is a healthy option for human and animal food because of its content of phytochemical compounds that would contribute to conserve and improve the state of health of those who consume it; These nutraceutical properties of maize are directly related to their phytochemical composition, which in turn depends on the variety of maize considered, so the study of the creole varieties of each region should be encouraged to know their particular nutritional, nutraceutical and biological properties (Lopez -Martinez and Garcia-Galindo, 2009. Castañeda-Sánchez, 2011. Salinas Moreno et al., 2012. Serna Saldívar et al., 2013).

Conclusion

According to the data obtained, an effect of the hydroethanolic extract of purple maize was observed, which diminished the gain of effect in mice when fed a diet high in fat. This effect is independent of appetite regulation because food or water intake was similar in all groups. Further studies should be carried out to know the active principles responsible for the effect and to elucidate its mechanism of action.

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