GRASAS Y ACEITES 74 (4)
October-December 2023, e527
ISSN-L: 0017-3495
https://doi.org/10.3989/gya.0878221

Impact of different treatments on the antioxidant properties of two market types of peanuts grown in Mexico

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Submitted: 27 August 2022; Accepted: 16 May 2023; Published online: 24 November 2023

SUMMARY: The effect of roasting, frying, microwave heating, and germination on the antioxidant properties, total phenolics and flavonoids content of two types of peanuts (Valencia and Virginia) grown in Mexico was investigated. The thermal treatments affected the phenolic content and the antioxidant capacity of the two varieties of peanuts differently (by ABTS, DPPH, FRAP and iron chelating activity methods). Germination was the best method to increase the antioxidant activity (up to 157% increase in the Virginia variety) and the contents of compounds with nutraceutical potential in the peanuts (up to 59% increase in total phenolics in the Valencia variety and 700% increase in total flavonoids in the Virginia variety). Germinated peanuts could be used as raw material for the production of functional foods.

KEYWORDS: *Antioxidant capacity; Peanut processing; Total flavonoids; Total phenolics*

RESUMEN: ***Efecto del procesamiento sobre las propiedades antioxidantes de dos tipos comerciales de cacahuete cultivados en México.*** Se investigó el efecto del tostado, fritura, tostado en microondas y la germinación, sobre las propiedades antioxidantes, el contenido de compuestos fenólicos totales y flavonoides de dos tipos de cacahuete cultivados en México. Los tratamientos térmicos afectaron de forma diferente al contenido de fenólicos y la capacidad antioxidante de las dos variedades de cacahuete (por los métodos de ABTS, DPPH, FRAP y actividad quelante de hierro). La germinación fue el mejor método para aumentar la actividad antioxidante (hasta en 157% en la variedad Virginia) y el contenido de compuestos con potencial nutracéutico de los cacahuates (hasta en 59% de aumento en los fenólicos totales de la variedad Valencia y 700% de aumento en los flavonoides totales de la variedad Virginia). Los cacahuetes germinados podrían usarse como materia prima para la producción de alimentos funcionales.

PALABRAS CLAVE: *Capacidad antioxidante; Fenólicos totales; Flavonoides totales; Procesamiento del cacahuete*

Citation/Cómo citar este artículo: Robles-Ramírez MC, Viramontes-Bocanegra R, Mora-Escobedo R, Ortega-Robles E, Beltrán-Orozco MC. 2023. Impact of different treatments on the antioxidant properties of two market types of peanuts grown in Mexico. *Grasas Aceites* **74** (4), e527. https://doi.org/10.3989/gya.0878221

1. INTRODUCTION

Currently, food scientists have focused their attention on the development of foods which, in addition to providing the basic nutrients for the maintenance of the organism, supply additional benefits to health, with particular interest in those which provide antioxidant compounds (Serafini and Peluso, 2016). A large number of research works support the role of oxidative stress in the pathogenesis of chronic degenerative diseases such as diabetes, obesity, cardiovascular disease, and cancer, which is why dietary antioxidants have become particularly important, since they counteract the oxidative damage to DNA, lipids and proteins by reactive oxygen species (Phan-Thien *et al*., 2014; Serafini and Peluso, 2016).

The peanut (*Arachis hypogaea* L.) is a legume which is highly consumed worldwide. It is a rich source of valuable nutrients such as dietary fiber, protein, oleic acid, niacin, folate, vitamin E, magnesium, manganese and phosphorous, as well as bioactive compounds, including phytosterols, arginine and phenolic compounds, which produce important beneficial effects on human health. Several studies have associated peanut consumption with a reduced risk of cardiovascular disease, obesity, diabetes, and cancer, among others (Robles-Ramírez *et al*., 2014). An important part of the nutraceutical properties of peanuts is due to their content of phenolic compounds (Chukwumah *et al*., 2007; Phan-Thien *et al*., 2014). These compounds have been shown to be useful in the prevention of diseases related to oxidative stress due to their antioxidant properties and their interaction with cell signaling pathways (Vauzour *et al*., 2010).

Peanuts are consumed as processed foods, either directly in the shell or in the form of peanut butter, peanut oil, snacks (salty, fried, spicy) and confectionery products (Robles-Ramírez *et al*., 2014). Regardless of the type of consumption, a previous heat treatment is applied to peanuts, generally by toasting in a conventional oven, or in oil, in order to decrease their microbial load, facilitate peeling, improve their sensory characteristics and decrease anti physiological factors (Chukwumah *et al*., 2007; Kumar *et al*., 2017). Microwave roasting has also been considered for blanching the peanuts because this method is fast, saves energy and is easy to control (Kumar *et al*., 2017).

On the other hand, there has been a growing tendency in the consumption of sprouts due to their high content of nutrients and nutraceuticals (Geng *et al*., 2021). Germination is an inexpensive and simple procedure during which several biochemical changes occur, improving protein digestibility, decreasing anti-physiological factors and increasing bioactive compounds, including phenolic compounds (Beltrán-Orozco *et al*., 2020). Different studies have demonstrated the increase in the content of phenolic compounds and in the antioxidant activity of different seeds during germination, such as soybeans, broad beans, mung beans, chia, amaranth, broccoli and wheat, among others (Fernandez-Orozco *et al*., 2008; Beltrán-Orozco *et al*., 2020; Geng *et al*., 2021).

The phenolic content and the antioxidant activity of peanuts can change depending on the geographic growth site and the genotype of seeds (Craft *et al*., 2010; Phan-Thien *et al*., 2014; Yang *et al*., 2019). Therefore, the objective of this work was to investigate the effects of dry, oil and microwave roasting, as well as the germination process, on the phenolic content and antioxidant properties of two types of peanuts grown in Mexico.

2. MATERIALS AND METHODS

2.1. Biological material

Peanuts (*Arachis hypogaea* L.) of two market types (Valencia and Virginia), obtained from different locations in Mexico, were used for this research. These varieties were selected based on their high production and preference among consumers. The Valencia peanuts were grown in the municipality of Temoac, Morelos (18° 46′ 20″ N, 98° 46′ 39″ W; 1583 mamsl, annual mean temperature of 19.8 °C, average annual precipitation of 1693 mm). Virginia peanuts were grown in Delicias, Chihuahua (28°11′36″N, 105°28′16″W; 1170 mamsl, annual average temperature of 27.7 °C, mean annual precipitation of 334.2 mm). Whole pods free of microbial contamination were selected and shelled to obtain the grains. Damaged or defective grains were removed and the different treatments were applied to the healthy grains.

2.2. Reagents

Folin-Ciocalteu reagent, ABTS (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid), DPPH (2,2-diphenyl-1-picrylhydrazil), TPTZ (2,4,6-tripyridyl-s-triazine), Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid), ferrozine, and sodium persulfate, were purchased from Sigma-Aldrich (St. Louis, MO).

2.3. Treatments

Peanuts were subjected to different types of processing (roasting, frying, microwave and germination) to subsequently evaluate their effect on the content of phenolic compounds, flavonoids and antioxidant activity. Untreated dry peanuts were used as a control. A batch of peanuts was dry-roasted in a preheated convection oven at 175 °C for 15 min. Another batch of peanuts was fried for 2.5 min at a ratio of 50 g of seeds in 200 mL of high oleic safflower oil preheated to 175 °C. Then, the excess oil was removed. For the microwave treatment, the peanuts were heated in a microwave oven (Panasonic,

model NN-6462A), at a frequency of 2.45 GHz and 450 W for 3.5 min. After each thermal treatment, the peanuts were cooled, the skin was removed and the skinless seed was ground. For the germination process, the peanuts were washed and disinfected by immersion in a chlorine dioxide solution (0.25 mL of a 10% solution for each L of water) for 10 minutes. Subsequently, they were soaked for 16 h in water at room temperature (23-25 °C), drained and placed in a plastic tray with a perforated lid, on a bed of cotton, covered with filter paper. The sprouts were collected after 3 days of germination, dried in an oven at 50 °C, and ground.

2.4. Proximate analysis

The moisture, protein, fat, ashes and dietary fiber contents of the samples were determined according to 925.10, 923.03, 920.39, 920.87 and 985.9 AOAC methods, respectively (AOAC, 1995).

2.5. Antioxidants extraction

Ground samples (2 g) were extracted by magnetic stirring using 20 mL of 80% methanol for 8 h. Afterwards, the extracts were obtained by filtration through Whatman No. 4 filter paper and stored at -20 °C until analysis.

2.6. Total phenolic content

The total polyphenol content of the samples was assessed using the Singleton *et al*. (1999) methodology. A volume of 20 µL of extract and 1.58 mL of distilled water were combined with 100 µL of Folin-Ciocalteu reagent (previously diluted 1:1 with water). The mixture was kept at rest for 5 min and then 300 µL of 10% sodium carbonate solution were added. After standing for 2 h at room temperature, the absorbance was measured at 765 nm. The results were expressed as mg of gallic acid equivalents per 100 g of dry sample (mg GAE/100 g).

2.7. Total flavonoid content

The method described by Ebrahimzadeh *et al*. (2008) was followed to determine the flavonoid content of the samples. A volume of 0.5 mL of the extract was combined with 1.5 mL of ethanol, 0.1 mL of 1 M potassium acetate, 0.1 mL of 10% aluminum chloride and 2.8 mL of distilled water. The absorbance was read at 415 nm after 30 min of standing at room temperature. A standard curve of quercetin was used to evaluate the flavonoid content of the extracts. The results were expressed in mg quercetin equivalents per 100 g dry weight sample (mg QE/100 g).

2.8. ABTS radical-scavenging activity

The ABTS radical-scavenging activity of peanut extracts was measured according to the method described by Re *et al*. (1999) with slight modifications. A solution containing 7 mM of ABTS and 2.45 mM of potassium persulfate was allowed to stand in the dark at room temperature for 16 h. This stock solution was diluted with ethanol until obtaining an absorbance of 0.7 ± 0.02 at 734 nm. Aliquots of 20 µL of the extracts or Trolox standard solutions were allowed to react with 1980 µL of ABTS•+ solution for 6 min and the absorbance was then measured at 734 nm. Results were expressed in µmol of Trolox equivalents per gram dry weight (µmol TE/g).

2.9. DPPH radical-scavenging activity

The assessment of DPPH radical-scavenging activity was carried out according to Brand-Williams *et al*. (1995). The extracts or Trolox standard solutions (100 µL) were mixed with 2 mL of 0.06 mM DPPH methanol solution and the absorbance measured at 515 nm after 30 min of incubation at room temperature. The antioxidant activity of the samples was expressed in µmol TE/g dry weight.

2.10. Ferric reducing antioxidant potential (FRAP)

The ferric reducing power of peanut samples was measured following the method described by Benzie and Strain (1996) with minor modifications. A working solution was prepared by combining 1 volume of 10 mM TPTZ in 40 mM HCl with 1 volume of 20 mM $FeCl_3 \cdot 4\ H_2O$ and 10 volumes of 300 mM acetate buffer, pH 3.6. The working solution (900 µL) was mixed with 90 µL of distilled water and 30 µL of the sample extract. This mixture was incubated at 37 °C for 30 min and the absorbance was read at 595 nm. The reducing power was calculated from a standard curve prepared by plotting the absorbance against the concentration of Trolox (300-1500 µM).

2.11. Metal chelating activity

To evaluate the ferrous ion chelating activity of the sample extracts, the method described by Ebrahimzadeh *et al*. (2008) was used with slight modifications. The methanolic extracts (0.5 mL) were mixed with 0.05 mL of 2 mM $FeCl_2$ solution. This mixture was left to stand for 5 min and then 0.1 mL of 5 mM ferrozine and 2.35 mL of 80% methanol were added. After 10 min of incubation at room temperature, the absorbance was measured at 562 nm. The iron chelating activity (%) was calculated according to the formula $(A_O - A_1) \times 100/A_O$, where A_O was the absorbance of the control, and A_1 the absorbance of the sample extract.

2.12. Statistical analyses

All determinations were made in triplicate and the results are expressed as the mean ± SD. One-way ANOVA and Tukey multiple comparison tests were used to analyze the differences between means ($p < 0.05$). The relationship between antioxidant compounds and antioxidant capacity measurements was evaluated using Pearson's correlation coefficient. Statistical analyses were carried out in SigmaPlot 13 software (Systat Software Inc., San José, CA, USA).

3. RESULTS AND DISCUSSION

3.1. Proximate analysis

The results of the proximate analysis are shown in Table 1. Both Virginia and Valencia varieties had high contents of protein, lipids and dietary fiber. However, the Virginia type peanuts showed significantly higher content of fat and dietary fiber than the Valencia variety, while the Valencia variety presented higher contents of protein and ashes. In general, the values obtained from the chemical analysis of peanuts were similar to those reported by Mora-Escobedo et al. (2015) in 8 Mexican cultivars. The differences observed in the composition of both varieties were probably due to their different genotype and growing conditions, as several studies have revealed (Craft *et al*., 2010; Phan-Thien *et al*., 2014; Yang *et al*., 2019).

3.2. Total phenolic content

The total phenolic and total flavonoid contents of peanuts preserved with the different treatments are shown in Figure 1A. The contents of total phenolic compounds of the Valencia variety without treatment were lower than those of the corresponding Virginia variety (198.17 and 273.26 mg gallic /100 g, respectively). However, both types of peanuts presented phenolic concentrations within the range of those found in other investigations, which fluctuated between 92 and 1458 mg GAE/100 g in different types and cultivars of peanuts (Craft *et al*., 2010; Win *et al*., 2011; Ferreira *et al*., 2016).

Processing affected the phenolic content of peanuts. In the case of the Virginia variety, the thermal treatments (roasting, frying and microwaving) slightly decreased the contents of phenolic compounds by 16.1%, 7.6% and 18.7%, respectively. In contrast, processing increased the contents of these compounds in Valencia peanuts (from 198.17 to 223.47, 215.36 and 228.84 mg GAE/100 g with roasting, frying and microwaving, respectively), with this difference being significant only for the microwave treatment.

Other studies carried out on peanuts (Ferreira *et al*., 2016; Chukwumah *et al*., 2007) showed that heat treatment significantly increased the amount of soluble phenolic compounds. These are found in the pericarp, the testa and the aleurone layers of the seed, either as free compounds or as esterified compounds which are conjugated to sugars and low-molecular weight components; whereas insoluble phenolic compounds are part of the cell wall of the seed cells, and are covalently bound to high-molecular weight components such as cellulose, hemicellulose, pectins, lignin and structural proteins, which makes their extraction difficult (Ferreira *et al*., 2016). Heat treatment could release the phenolic compounds from the complex structures to which they are attached (Win *et al*., 2011). This would explain the increment of the polyphenolic content of Valencia peanuts after heating. Microwave showed to be better for increasing the polyphenol content of this type of peanuts. Thermal conductivity determines how evenly the temperature is internally dispersed in a material when it is heated conventionally. However, microwave heating generates intense heat throughout the food's structure rather than just at the surface. This causes a greater release and extraction of polyphenols. However, the effect of heat processes on the phenolic and nutrient composition of the grains depends on their size, thickness, form and internal structure, characteristics which may vary with genotype and growth conditions (Ferreira *et al.,* 2016; Kumar *et al.,* 2017). Ali *et al*. (2016) also

Table 1. Proximate analysis of peanut seeds (g/100 g)

Component	Virginia	Valencia
Moisture	3.64 ± 0.06 a	4.31 ± 0.01 b
Protein	27.51 ± 0.32 a	29.64 ± 0.36 b
Lipids	44.79 ± 0.18 b	42.62 ± 0.29 a
Insoluble fiber	13.16 ± 0.90 b	7.09 ± 1.05 a
Soluble fiber	4.25 ± 0.15 b	3.81 ± 0.18 a
Total dietary fiber	17.41 ± 1.04 b	10.91 ± 1.27 a
Ash	2.38 ± 0.01 a	2.85 ± 0.03 b

Values are the mean ± SD (n=3). Different letters in the same row indicate significant differences ($p < 0.05$) according to One-way ANOVA/Tukey's test.

reported an increase in total phenolic compounds in a time-dependent manner, when peanuts were roasted from 0 to 7.5 min in a microwave oven at a frequency of 2450 MHz and 350 W. Craft *et al*. (2010) investigated the effect of roasting and frying on the phenolic content of different varieties and commercial types of peanuts, finding that the type, cultivar and harvest date had an influence on the response to treatment, impacting both the profile and the quantity of phenolic compounds. Rosales-Martínez (2014) observed that during oven roasting of Virginia-type peanuts there was an increase in the phenolic compounds from 370 to 457 mg GAE /100 g sample, while Chukwumah *et al*. (2007) did not obtain any change when frying or roasting this type of peanuts. As can be seen, the behavior of polyphenols after the heat treatments is variable, depending on the peanut variety and the type of thermal process. However, the total content of polyphenols was not highly modified with processing, and the possible benefits to consumers were not affected.

Both varieties of peanuts showed a significant increase in the content of total phenolic compounds during germination, which was consistent with their high biological activity (germination percentages higher than 93%). The Virginia variety showed an increase of 8% and the Valencia variety an increase of 59%. This behavior has also been observed in studies with other seeds. For example, Fernandez-Orozco *et al*. (2008) observed increases between 50 and 300% in different legumes with 4-7 days of germination, while Beltrán-Orozco *et al*. (2020) obtained a 300% increase in the phenolic content of chia seeds after 4 days of germination. The phenolic compounds have been studied as secondary metabolites used by plants in defense against insects, microorganisms and parasitic plants, as well as for their role as signaling molecules to maintain seedling survival (Ndakidemi and Dakora, 2003). Germination possibly triggered the synthesis of phenolic compounds and also caused the release of these compounds from the food matrix of peanut seeds.

3.3. Total flavonoid content

Figure 1B shows the changes in the total flavonoid content observed in both varieties of peanuts subjected to the different treatments. In summary, the Virginia variety showed increases of 70, 74 and 45% in the flavonoid content of peanuts treated with oven roasting, frying and microwave, respectively; while the Valencia variety showed a reduction with roasting, a non-significant change with frying and a 31% increase in the flavonoid content in microwave-treated seeds.

In contrast, Ali *et al*. (2016) found that microwave heating decreased the content of flavonoids in a Bangladeshi peanut cultivar, suggesting their degradation. On the other hand, Chukwumah *et al*. (2007) found that neither oven roasting nor frying increased or modified the total flavonoid content of peanuts; while boiling caused an increase of 20%. This increment was attributed to the presence of proanthocyanidins in the peanut skin. Proanthocyanidins are oligomers of flavan-3-ol, such as catechin, epicatechin and epigallocatechin, which may have migrated from the hull to the cotyledons during thermal treatment. Epicatechin is a flavonoid which has diverse beneficialhealth properties such as antioxidant, anti-inflammatory, antitumor, cardioprotective and neuroprotective activities (Prakash *et al*., 2019). These researchers obtained values of 5 mg QE/100 g in raw Virginia type peanuts with skin and 1 mg QE/100 g in raw peanuts without skin; while in the present work averages of 1.75 and 2.31 mg QE/100 g were found for Virginia and Valencia peanuts, respectively.

It is important to note that germination significantly increased the flavonoid content (approximately 700% in the case of the Virginia variety and 400% in the Valencia variety) probably due to the role that these compounds play in plants to combat predator attack, decrease oxidative stress and as growth regulators, as mentioned above (Ndakidemi and Dakora, 2003). This fact is very important given that flavonoids are the phenolic compounds with the greatest

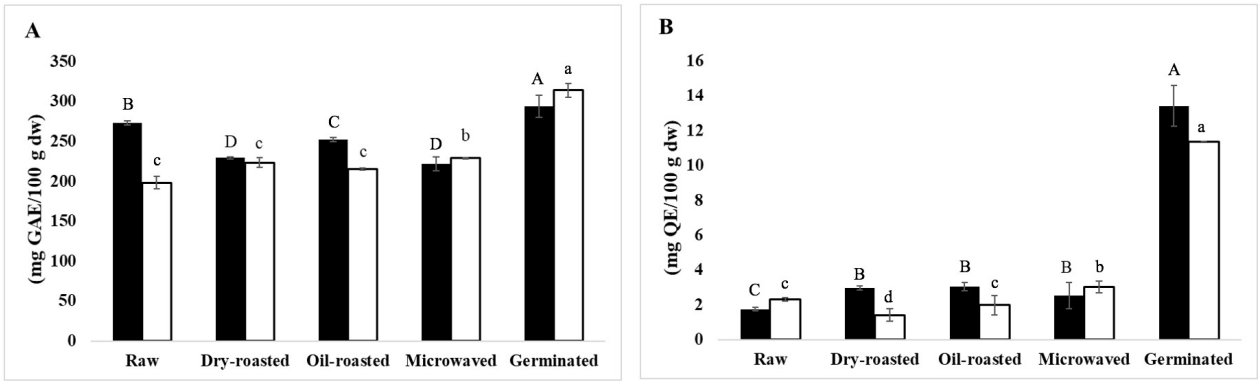

Figure 1. Total phenolic compounds (A) and total flavonoid compounds (B) of Virginia (■) and Valencia (□) peanuts subjected to different treatments. Values are mean ± SD (n=3). Different letters indicate significant differences among treatments according to One-way ANOVA/Tukey's test ($p < 0.05$).

beneficial effects on human health such as antioxidant and anti-inflammatory activities, free radical scavenging capacity, cardiovascular disease prevention, neuroprotective, hepatoprotective, anticancer and antiviral activities, among others (Kumar and Pandey, 2013).

3.4. ABTS radical scavenging activity

Figure 2A shows the antioxidant activity of peanuts as determined by the ABTS method. Results of 12.73, 11.24, 10.93, 11.09, and 14.5 µmol Trolox/g sample were obtained for the Virginia variety, and 11.16, 9.74, 11.11, 11.62, and 12.95 µmol Trolox/g sample for the Valencia variety, in raw, roasted, fried, microwave-treated and germinated samples, respectively. There was no significant difference between the control and the peanuts treated by the different thermal methods, although a tendency to decrease with roasting was shown in the Valencia variety. In the case of the Virginia variety, values of 12.5 to 16.5 µmol Trolox /g of sample without treatment were reported using the ABTS method (Mahatma, 2016), similar to those obtained in this study. On the other hand, Craft *et al.* (2010) obtained values between 3.02 and 11.99 µmol Trolox /g in different types and varieties of peanuts. These researchers found that the antioxidant capacity of peanuts subjected to different heat treatments (dry and oil-roasted) depended on the type, variety and age of the peanut.

A tendency to increase the antioxidant capacity (ABTS method) with germination was also observed in both types of peanuts, although the difference was not significant. Germination has been shown to increase the antioxidant capacity of other legumes such as mungbean (Geng *et al*., 2021), soybeans (Fernandez-Orozco *et al*., 2008), and lupine (Dueñas *et al*., 2009).

There was a positive correlation between total polyphenol content in the raw samples and the antioxidant activity determined by the ABTS method (r = 0.99). However, this correlation decreased in the treated samples (r = 0.82). These results show that polyphenols are mainly responsible for the antioxidant activities of peanuts and that processing generates new compounds that contribute to the antioxidant capacity. For instance, the increased synthesis of the Maillard reaction products during peanut roasting has been related to their higher antioxidant capacity. These comprise phenolic and non-phenolic compounds that could act as free radical scavengers (Kumar *et al*., 2017).

3.5. DPPH radical scavenging activity

Figure 2B shows the antioxidant activity of peanuts following the DPPH method. Results of 3.49, 3.6, 2.98, 3.8, and 8.97 µmol Trolox/g sample were obtained for the Virginia variety, and 5.48, 2.22, 5.69, 4.43, and 8.47 µmol Trolox/g sample for the Valencia variety, in raw, roasted, fried, microwave-treated and germinated samples, respectively. Compared to the unprocessed sample, there was a significant decrease in the antioxidant capacity of the Virginia type peanut when it was fried (14%) and in the Valencia type when it was roasted (60%) or microwave-treated (20%). The roasting conditions (175 °C, 15 min) probably changed the profile of the antioxidant compounds to others with lower antioxidant capacity or there was degradation of the compounds already released or formed.

However, Win *et al*. (2011) reported an increase in the antioxidant activity of peanuts as roasting time increased, at least for the Virginia variety. They found that the samples treated at 160 °C for 20 to 50 minutes showed higher DPPH radical-scavenging activity than untreated and 10 min-treated samples. This was attributed to the release of antioxidant compounds from the cell matrix to which they were attached. This can also be attributed to phenolic and non-phenolic compounds derived from Maillard reactions (Kumar *et al*., 2017).

Germination significantly increased the antioxidant capacity of the two peanut varieties, as determined by the DPPH method. An increase of 257% was obtained for the Virginia variety while in the Valencia variety there was an increase of 154.6%. These values were higher than those obtained by the ABTS method. The DPPH method detects the activity of low-molecular weight antioxidants since the DPPH radical presents a problem of steric inaccessibility (Prior et al., 2005). Therefore, small molecules, which have better access to the radical site, will show an apparent greater antioxidant activity by this method. Low-molecular weight antioxidant compounds were probably released or synthesized during germination.

Khang *et al*. (2016) studied the effect of germination (5 days) on the content of phenolic compounds and the antioxidant activity of six different legumes. Peanuts showed higher antioxidant capacity than soybeans, mung beans, white cowpeas, black beans and Adzuki beans, as determined by the DPPH method. All these legumes showed an increase in the content of total phenolic compounds as germination time increased.

3.6. Ferric reducing antioxidant power (FRAP)

The FRAP method determines the reducing power (electron transfer) of antioxidants, which is related to their degree of hydroxylation and conjugation (Prior *et al*., 2005). In Figure 2C it can be seen that roasting favored the formation of reducing compounds in both varieties of peanuts (increase of 8.3% and 31.8% in the Virginia and Valencia varieties, respectively).

Similarly, Thummakomma *et al*. (2018) obtained an 18% increase in the antioxidant activity (FRAP) of home-roasted peanuts.

The two varieties of peanuts responded differently to frying and microwave heating. Frying increased the reducing capacity of the Virginia variety, but decreased that of the Valencia variety; while microwave heating decreased the reducing power of the Virginia variety and increased that of the Valencia variety. Ali *et al*. (2016) found that microwave heating increased the reducing power of peanuts grown in Bangladesh by up to 7 times, depending on both heating power and time.

Germination increased the reducing power of the Virginia and Valencia varieties by 31.8 and 81.7%, respectively. Therefore, peanut germination generated the production of compounds with reducing power as well as free radical scavengers. In the study of Khang *et al*. (2016) peanuts showed higher reducing power than five other legumes (soybeans, mungo beans, white cowpeas, black beans and Adzuki beans), which demonstrates the high antioxidant potential of this legume.

3.7. Metal chelating activity

Figure 2D shows the metal chelating activity of peanut extracts. The transition metal ion Fe^{2+} has the capacity to transfer individual electrons, thus promoting the generation and spread of numerous radical reactions. The chelation of metal ions is the primary method for preventing the production of reactive oxygen species (ROS) associated with redox active metal catalysis (Ebrahimzadeh *et al*., 2008). The methanolic extracts from the raw samples of both varieties of peanuts had high chelating activity (above 90%) and none of the treatments significantly affected this capacity except in the Valencia variety, in which germination caused a slight decrease in chelating activity. The IC_{50} varied from 0.11 to 0.18 mg/mL.

4. CONCLUSIONS

In this study it was found that the response to the different treatments in the content of total phenolic compounds, flavonoids and antioxidant activity depended on the variety of peanut. However, the treatments commonly used to improve the sensory qualities of this oilseed (roasting and frying) did not greatly affect the antioxidant content in peanuts and, in some cases, even increased it. Germination was the best method to increase the antioxidant activity and the content of compounds with nutraceutical potential in peanuts, thus geminated peanuts could be used as raw material to produce functional foods and nutraceuticals.

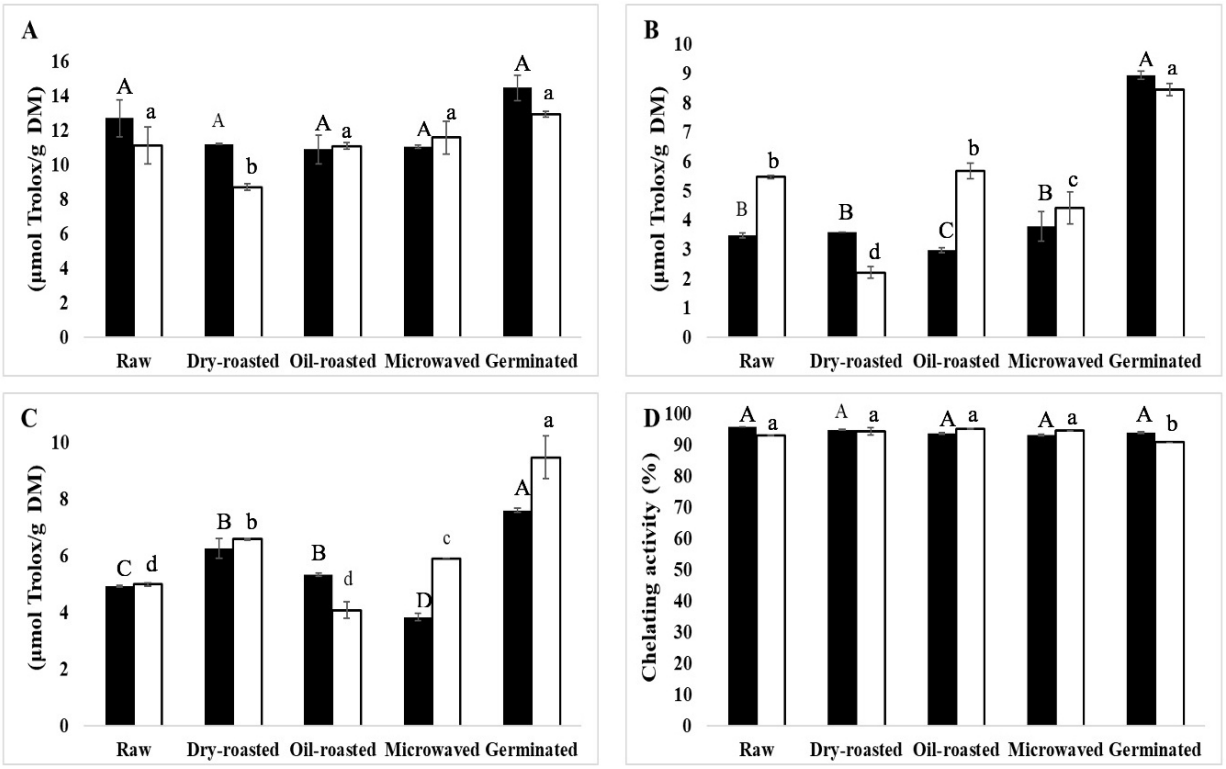

Figure 2. Antioxidant activity as determined by the ABTS method (A), DPPH method (B), reducing power (C) and ferrous chelating activity (D) of Virginia (■) and Valencia (□) peanuts subjected to different treatments. Values are mean ± SD (n=3). Different letters indicate significant differences among treatments according to One-way ANOVA/Tukey's test ($p < 0.05$).

ACKNOWLEDGMENTS

The authors thank the Instituto Politécnico Nacional for financial support (project 20171684). MCRR, RME and EOR are SNI fellows.

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