J. Food and Dairy Sci., Mansoura Univ., Vol. 8 (8): 361 - 367, 2017

Sensory, Nutritional and Popping Qualities of Yellow and Purple Popcorn.

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ABSTRACT

The aim of the present study was to evaluate the sensory, nutritional and popping qualities of two types of popcorn grains (*Zea mays*, L.) yellow and purple popcorn under different methods of expansion. Popping processes applied were: in a pan with oil, in an electrical popper with and without oil. The purple popcorn is superior in protein (12.56%), crude fiber (3.58%) and ash content (1.89%), whereas yellow popcorn has 10.84%, 2.27%, 1.03% for protein, crud fiber and ash content, respectively. Obviously, the higher the preference for the tasters was the popcorn produced by the electrical popper with oil, for both yellow and purple popcorn. The carotenoid content increased when popping with oil was applied on contrary to popping without oil. The highest content of anthocyanin could be traced in unexpanded purple popcorn, but decreased with the different forms of popping process. Yellow and purple popcorn grains had 1.19 and 1.58 mg of gallic acid / g sample, respectively and significant increase was figured out in the total phenolic availability after popping in pan with oil in both yellow and purple popcorn. The expansion volume of yellow and purple popcorn by the same expansion method was insignificant, but significantly different from those expanded with and without oil.

Keywords: Yellow popcorn, purple popcorn, sensory, nutritional, popping quality

INTRODUCTION

Popcorn is small flint maize (*Zea mays* everta), it considered one of the most favorite and popular snacks which is consumed widely worldwide and popcorn is the original American snack (Eckhoff and Paulsen, 2003). Varieties of corn vary in composition and color. Yellow popcorn has become one of the favourite snack foods, today there are white, yellow, brown, green, red, purple, and blue varieties. Purple corn is a pigmented variety originally cultivated in Latin America (Yang & Zhai, 2010). Popularity of popcorn has been increasing over time throughout the world (Hallauer, 2004). Popcorn is a dish made from a special variety of corn that is distinguished by a glassy endosperm, by being thicker than normal and by having hard grains of maize and consumed as a nutritious snack with excellent functional properties (Quinn *et al*., 2005). According to Tandjung *et al*., (2005) the popcorn grains when heated quickly and evenly, the components of cell wall such as the arabinoxylans and the pulp, undergo molecular changes that leave them more rigid and crystalline. Likewise, the inner water is converted into steam, and at a certain point, the internal pressure causes an expansion of the pericarp that changes the small amount of oil inside and the starch and fiber, resulting in a format larger than the original grain (Soylu and Tekkanat, 2007). A maize rich in anthocyanins such as purple popcorn, is suitable to be transformed into a snack could help to introduce healthy antioxidant compounds in the diet of many people, contributing to the prevention of chronic diseases (Virgili and Marino 2008 & Lago *et.al*., 2013). Meanwhile Lopez-Martinez *et al.,* (2009) found that the purple corn have the highest phenolic content, anthocyanin content and radical scavenging activity which are useful to protect human health by preventing chronic diseases.

Poping quality is measured by expansion volume, the flake size, and the percent of unpopped grains as reported by Len and Anantheswaran (1988). Expansion volume related to popped corn texture, mouthfeel and appearance. Hoseney (1994), reported that the crispness and tenderness have been positively correlated with expansion volume. This volume is important for both the consumer and the manufacturer because the popcorn grains buys by weight and sells as popped corn by volume. The aim of the investigation was to evaluate the sensory, nutritional and popping qualities of two types of popcorn grains (*Zea mays*, L.) yellow and purple popcorn under different methods of expansion.

MATERIALS AND METHODS

Materials

Yellow and purple popcorn grains were purchased from local supermarket in Tabuk, Kingdom of Saudi Arabia.

Methods

Preparation of popping corn

The grains were subjected to three popping methods in triplicate for each method: (1) pan with oil; (2) electrical popper with oil and (3) electrical popper without oil. Corn oil was added at 4% for those expansion processes in which oil was used, and then mixed by glass rod until the entire surface of the grains was covered with the oil. According to Hoseney *et al*., (1983), the discontinuation of all expansion processes investigated here was standardized by using a 5 second time interval between the expansions of one grain to the next. When the pressure and the internal temperature of the grains reach at least 135 psi and 177 ˚C, respectively the expansion of grains occurs. The expanded and non-expanded grains were ground in a German Brown Mill with a sieve of number 35 mesh to achieve a uniform grain size for the samples and to perform the analysis.

Proximate chemical composition and energy value:

Proximate chemical composition was determined for yellow and purple unexpanded grain as a percentage (%). Moisture content was determined by drying oven set at 105 °C with natural air circulation according to (ASAE, 2000). Fat, protein and ash content were determined following the method of AACC, (1995). Crude fiber content was determined using the analytical protocol described by Angelucci *et al.* (1987). Nitrogen free extract was calculated by difference. Energy value was calculated considering the energy value of 4 kcal/ g protein, 9 kcal/ g lipids and 4 kcal/ g carbohydrates according to Paraginski *et al* (2016).

Sensory evaluation

Sensory evaluation was performed for popping corn from two types as described by Minin (2010). The evaluation was performed with 40 untrained judges, including employees and students, Tabuk University. The participation was interest and positive. The participants ranged in age from 17 to 60 years. The tasters expressed their judgment according to a scale from 1for the worst, to 10 for the best. The results were processed by determining the critical values of the difference of the sum of orders for comparing the treatments with each other ($P \leq 0.05$) based on the Friedman test. The tasters were asked to observe color, odor, taste, texture, shape and over all acceptability.

Antioxidant compounds and activity:

Total carotenoids content

The total carotenoid content was determined by the method proposed by Rodriguez-Amaya (2001) with some modifications and expressed as mg equivalents of ß-carotene / g sample. Three grams of ground sample were weighed in a Falcon tube (protected from light), and 20 ml of distilled water were added and vortexed for 60 s. The tubes were placed in a water bath at a temperature of 85 °C for 5 min, removed, vortexed again, stirred for 60 s, and then placed in the bath for another 5 min. The tube was removed and 30 ml of acetone cooled with antioxidant (0.01%) were added, stirred, and then vortexed for 60 s. The material was filtered on paper on the inside of the 200 ml beaker, and the solid residue was suspended again in 30 ml of acetone and vortexed for 60 s twice. The extract was placed in a separation funnel with 20 ml of petroleum ether carried by separation with 300 ml of distilled water for 15 min, discarding the bottom. This was performed three separate times. At the end of the process when all of the extract was added, the carotenoid content was dissolved in petroleum ether, and this volume was measured in a 25 ml volumetric flask in 1 g of anhydrous sodium sulfate, flasks were shaken and then read on a spectrophotometer (Shimadzu Co., Columbia, SC, USA) at a wavelength of 450 nm.

Total anthocyanins content

According to the method proposed by Abdel-Aal and Hucl (2003), the total anthocyanin content was determined in yellow and purple maize before and after popping by different expansion. The extraction was conducted with 500 mg of sample extracted by mixing with 10 ml of methanol acidified with 1N HCl (85:15, v/v) and stirred at 170 rpm for 30 min at room temperature. The crude extract was centrifuged at 8000 g for 20 min at room temperature, and the absorbance of the supernatant was measured in a spectrophotometer (Shimadzu Co., Columbia, SC, USA) at 535 nm to detect anthocyanins. The anthocyanin levels are expressed in mg equivalents of cyanidin 3-glucoside (CGE)/ kg on a dry basis using the molar extinction coefficient of 25.965 Abs/M x cm and a molecular weight of 449.2 g/ mol.

Total phenolics content:

Extraction process

The extract was obtained according to the methodology proposed by **Shen *et al.* (2009**) with some modifications. Five grams of the sample were weighed in Falcon tubes and added to 20 ml of acidified methanol (1% HCl PA). The solution was stirred at 170 rpm for 24 h at 25°C (room temperature). The methanolic extracts were centrifuged at 6000 rpm for 20 min at 25°C (Eppendorf Centrifuge 5430R), and the supernatants were stored at 4°C to perform the analysis of total phenolics and antioxidant activity by the DPPH as described by **Brand-Williams *et al.* (1995**).

Determination of total phenolics

The total phenolics content was determined according to the Folin-Ciocalteu procedure (Zielinski and Kozlowska, 2000). Briefly, the extract (500 µl) was transferred into a test tube and oxidized with the addition of 250 µl of Folin-Ciocalteau reagent. After 5 min, the mixture was neutralized with 1.25 ml of 20% aqueous Na_2CO_3 solution. After 40 min, the absorbance was measured at 725 nm against the solvent blank. The total phenolics content was determined by means of a calibration curve prepared with gallic acid, and expressed as µg of gallic acid equivalent (GAE) per g of sample.

Antioxidant activity by radical DPPH scavenging activity.

The antioxidant activity using the stable 1,1-Diphenyl-2-picryl-hydrazyl (DPPH method was determined with 10 mL of extract and 90 mL of methanol, after which 3.9 ml of the DPPH solution was added with an absorbance between 1.080 and 1.120 nm. The mixture was vortexed and the reading was carried out using a spectrophotometer at 515 nm after 2 h and 30 min, with the instrument zeroed with methanol. The antioxidant activity was calculated as µM of trolox/ Kg sample.

Popping quality:

Sample (25 g) of each treatment was weighed and counted before popping. The popped volume was measured in a 1000 ml graduated cylinder. The numbers of unpopped grains was determined by transferring the popped corn to an 8 mm square hole screen .Three major parameters of interest to industry are the expansion volume, the flake size, and the percent of unpopped grains were calculated as outlined by Mohamed *et al*. (1993), who respectively assigned the following variables to the aforementioned three parameters with their proper definitions:

Expansion volume =

total popped volume(Cm^3)/original sample weight (g)

Flake size =

total popped volume(Cm^3)/ number of popped grains

Unpopped ratio (%) =

100X(number of unpopped grains/original number of grains*)*

The measure was repeated 5 times.

Statistical analysis

Data were based on averages (from 3 measurements per determination) ± standard deviations were reported. The means were compared between yellow and purple popcorn using Tukey's test at a 5%

level of significance using analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Proximate Chemical Composition and energy value.

Proximate chemical composition of yellow and purple unexpanded grains is shown in Table (1). Moisture, protein, crude fiber, ash and energy value shown significant differences between the yellow and purple popcorn grains in terms of. The purple popcorn is superior in protein (12.56%), crude fiber (3.58%) and ash content (1.89%), whereas yellow popcorn has 10.84%, 2.27%, 1.03% for protein, crud fiber and ash content, respectively. Smith *et al*. (2004) decided that the protein, lipid, ash, fiber and starch contents of corn grains were 10, 3.5-4.5, 1.5-2, 1.5-2.1 and 65-70%, respectively thus these results are in agreement with the current study. Ziegler *et al*. (1984) found that the popcorn provides 78.77% of carbohydrates, 12.94% of proteins, 4.54% of fats. That is why popcorn is one with the best nutritional features.

Table 1. Proximate chemical composition (% on dry weight basis) and energy value (K calorie) of yellow and purple popcorn grains.

Pericarp color	Moisture	Protein	Crud fat	Crude fiber	Ash	NFE *	Energy value
Yellow popcorn	$11.49{\pm}0.17^{a}$	10.84 ± 0.55^{b}	$4.51{\pm}0.22^{a}$	$2.27{\pm}0.07^{b}$	$1.03{\pm}0.42^{b}$	68.86 ± 0.79^{a}	$371.93{\pm}26.83^{a}$
Purple popcorn	$10.73{\pm}0.31^{b}$	12.56 ± 0.24^{a}	3.95 ± 0.20^{a}	$3.58{\pm}0.21^{a}$	1.89 ± 0.61^{a}	67.29 ± 0.83^{a}	$362.11{\pm}19.94^{b}$

***NFE: nitrogen free extract, Protein factor= N×6.25.**
Mean ± Standard deviation, Different letters in each column indicate statistically significant difference (P≤0.05)

Sensory Evaluation:

Sensory preference results of popcorn grains with yellow and purple pericarps popped by three different processing methods are shown in Table (2). The data did not reveal significantly differences among expanded methods for color and odor because once expanded, yellow and purple popcorn had the similar color and to some extent the same odor. The differences were significant ($P \leq 0.05$) for yellow and purple popcorn in taste, softness and overall acceptable. Obviously the higher the preference for the tasters was the popcorn produced by the Electrical popper with oil, with no significant different between yellow and purple popcorn expanded by electrical popper with oil.

Table 2. Sensory evaluation of yellow and purple popcorn by different expansion methods.

Pericarp color	Expanded methods	Color	Odor	Taste	Softness	Overall acceptable
Yellow popcorn	Pan with oil	$8.4{\pm}0.35^{a}$	$9.2{\pm}0.26^{a}$	$8.3{\pm}0.43^{ab}$	$8.2{\pm}0.62^{b}$	$9.0{\pm}0.53^{a}$
	Electrical popper without oil	$8.2{\pm}0.81^{a}$	$9.0{\pm}0.18^{a}$	$7.5{\pm}0.66^{bc}$	$7.5{\pm}0.31^{b}$	$8.2{\pm}0.45^{b}$
	Electrical popper with oil	$8.4{\pm}0.53^{a}$	$9.6{\pm}0.4^{a}$	$9.0{\pm}0.41^{a}$	$8.5{\pm}0.52^{a}$	$9.3{\pm}0.52^{a}$
Purple popcorn	Pan with oil	$8.2{\pm}0.65^{a}$	$9.3{\pm}0.42^{a}$	$8.0{\pm}0.36^{b}$	$8.1{\pm}0.52^{b}$	$9.3{\pm}0.27^{a}$
	Electrical popper without oil	$8.0{\pm}0.62^{a}$	$9.1{\pm}0.52^{a}$	$7.2{\pm}0.53^{c}$	$7.8{\pm}0.68^{b}$	$8.5{\pm}0.51^{b}$
	Electrical popper with oil	$8.1{\pm}0.74^{a}$	$9.3{\pm}0.51^{a}$	$8.5{\pm}0.26^{a}$	$9.2{\pm}0.36^{a}$	$9.5{\pm}0.35^{a}$

Mean ± Standard deviation, Different letters in each column indicate statistically significant difference (P≤0.05) between all forms for both types.

These data agree with Paraginski *et al* (2016), who reported that popcorn is preferred in the presence of oil because the oil improve the better characteristics acquired during the expansion. Ceylan and Karababa (2004) studied the effect of adding vegetable oil during the expansion of popcorn and found that the addition of up to 10% vegetable oil increases the volume expansion and promotes a more uniform heating of the grains during expansion; another factor is that the presence of oil provides a resistance to water vapor outlet from the interior of the grains. The combination of these two factors allows a greater increase in the internal temperature of the grains, thereby improving the expansion characteristics. The expansion depends on the methods of processing, humidity, genotype, physical integrity, drying temperature and postharvest practices as reported by Gokmen (2004).

Antioxidant compounds and activity:

The results of total carotenoids as ß-carotene, anthocyanins as cyanidin-3-glicosídeo, total phenolic compounds as gallic acid and antioxidant activity as trolox in yellow and purple popcorn before and after popping by different expansionmethods are presented in Table (3). Data indicate that the differences among all samples understudy were significant ($P \leq 0.05$). Carotenoids content in yellow unexpanded popcorn (17.07 mg ß-carotene /kg) was found to be higher than its counterpart in purple popcorn (14.87 mg ß-carotene /kg). The highest content of carotenoids (19.63 mg ß-carotene /kg) was traced in yellow popcorn expanded in pan with oil, whereas the lowest content was found in purple popcorn expanded in electrical popper without oil. In general, the carotenoid content increased when popping with oil, on contrary to popping without oil as compared to the grains unexpanded. This increase in the carotenoid is the result of corn oil that added to the expansion of grains because it is known that corn oil have high concentrations of carotenoids. The reduction in the carotenoids content for the yellow and purple popcorn in the electrical popper without oil is due to the degradation of carotenoids because of the thermal instability of carotenoids compounds as reported by (Nonier *et al*., 2004). The highest content of anthocyanin (7.29 mg cyanidin-3-glicosídeo/kg) found in unexpanded purple popcorn, which decreased with the different forms of popping process. The highest decreased value observed in purple popcorn after popping in pan with oil (3.35 mg cyanidin-3-glicosídeo/kg). This decrease in anthocyanins values can be explained by the low stability of anthocyanins upon heating, as reported by Nayak *et al* (2011). In contrast in yellow popcorn there was increase of anthocyanins content from 1.03 mg cyanidin-3-glicosídeo/kg in grains to 1.67 mg cyanidin-3-glicosídeo/kg after popping in pan with oil, increase of anthocyanins concentrations may be given because the interfere with compounds formed by darkening of the grain when poping, these compounds can be extracted along anthocyanins according to Paraginski *et al*.(2016) . Some studies have shown that thermal treatment was able to increase the antioxidant activity of various vegetables, among them sweet corn. This effect has been explained by considering the Maillard reaction products (Dewanto *et al*. 2002; Nindo *et al*. 2003). Lago *et al*. (2014) found that the steam treatment caused a small decrease in the anthocyanins content of the red sweet corn from 118.92 mg /100 g in the fresh seeds fell to 96.82 mg/ 100 g, but the effect of the autoclave cycle was dramatic, destroying a large part of the anthocyanins, which reached the final amount of 19.6 mg/ 100g. The same pattern was found for the phenolic acids, with the red corn 81.043 mg/ 100 g before and 156.66 mg/100 g after the treatment and the yellow corn 31.23 mg /100 gm before and 64.07 mg/100g after the steam treatment.

Table 3. Total carotenoids (mg ß-carotene /kg), total anthocyanins (mg cyanidin-3-glicosídeo/kg), phenolic compounds (mg gallic acid /g) and antioxidant activity (µM of trolox/ Kg) in yellow and purple popcorn before and after popping in different methods.

Pericarp color	Forms of popcorn	Total carotenoids	Total anthocyanins	Phenolic compounds	Antioxidant activity
Yellow popcorn	Unexpanded	17.07±1.03^{c}	1.03±0.38^{e}	1.19±0.42^{d}	0.51±0.06^{a}
	Expanded in pan with oil	19.63±0.87^{a}	1.67±0.42^{d}	1.76±0.39^{a}	0.46±0.25^{ab}
	Expanded in electrical popper without oil	16.38±0.74^{c}	1.32±0.22^{de}	1.31±0.74^{c}	0.37±0.08^{ab}
	Expanded in electrical popper with oil	18.92±0.49^{b}	1.51±0.34^{de}	1.39±0.28^{c}	0.42±0.03^{ab}
Purple popcorn	Unexpanded	14.87±0.06^{e}	7.29±0.81 ^{a}	1.58±0.64^{b}	0.23±0.03^{ab}
	Expanded in pan with oil	16.21±1.32^{c}	3.35±0.36^{c}	1.91±0.51^{a}	0.21±0.07^{ab}
	Expanded in electrical popper without oil	13.66±0.48^{f}	5.19±0.28^{b}	1.47±0.44^{c}	0.17±0.04^{b}
	Expanded in electrical popper with oil	15.35±0.74^{d}	5.74±0.74^{b}	1.38±0.53^{c}	0.17±0.03^{b}

Mean ± Standard deviation, Different letters in each column indicate statistically significant difference (P≤0.05) between all forms for both types.

Yellow and purple popcorn grains had 1.19 and 1.58 mg of gallic acid/g sample, respectively. It was observed that there was a significant increase in the total phenolics availability after popping in pan with oil in both yellow and purple popcorn. These results for phenolic compounds in our study is agreement with that found by Paraginski *et al*. (2016), who recorded that the content of phenolic compounds in the whole popcorn grains for grains with red, white and yellow pericarps were 1.45, 1.33 and 1.02 mg of tannic acid g-1, respectively. Results we given here less than the results of Zilic *et al*. (2013), who identified total phenolic compounds in maize 5.77 mg gallic acid /g. For the effect of phenolic compounds after expanded, there were significant differences ($P \leq 0.05$) in both types under study before and after popping. The phenolic compounds for yellow popcorn after and before popping expansion in pan with oil increased ($P \leq 0.05$) from 1.19 to 1.76 mg of gallic acid/g, respectively. This was also true for purple popcorn since the phenolic compounds increased by popping in pan oil. According to Acosta-Estrada *et al*. (2014), the increase of phenolic compounds probably is related to the release of phenolic compounds by action of the heat after expanded process.

The antioxidant activity by radical DPPH scavenging method (Table 3), showed no significant differences ($P \leq 0.05$) in the yellow popcorn made by different popping methods. Purple popcorn exhibited significant differences ($P \leq 0.05$) as compared with expanded and unexpanded grains. The antioxidant activities were 0.51 and 0.23 µM of trolox / Kg for the yellow and purple unexpanded popcorn, respectively. After expansion, the highest values were observed in the grains popped in the pan with oil for both yellow and purple popcorn. These observations are in good agreement with Paraginski *et al*. (2016). The results from Table (3) show that the best process to make popcorn is expansion in pan with oil. The information about the antioxidant compounds in accordance with the color of the pericarp and the expanded methods is useful for the consumer and may assist him in the choice of a particular food or form of processing.

Popping quality:

The data of unpopped ratio (%), the flake size (Cm^3), and the expansion volume (Cm^3/gm) for yellow and purple popcorns after the expansion by different methods are presented in Table (4). Percentage of unpopped ratio showed no significant difference ($P \leq 0.05$) among to yellow and purple popcorn expanded by pan with oil, electrical popper with oil and electrical popper without oil. Unpopped ratio ranged between 2.81 % for purple corn expanded by electric popper without oil to 2.21% for yellow corn expanded by electric popper with oil.

Table 4. Unpopped ratio (%), flake size (Cm^3) and expansion volume (Cm^3/gm) of yellow and purple popcorn expanded with different methods

Pericarp color	Expanded methods	Unpopped ratio (%)	Flake size(Cm^3)	Expansion volume (Cm^3/gm)
Yellow corn	Pan with oil	2.47 ± 0.05^a	3.19 ± 0.88^c	25.07 ± 1.04^a
	Electrical popper without oil	2.67 ± 0.20^a	3.61 ± 0.86^b	23.22 ± 2.04^b
	Electrical popper with oil	2.21 ± 0.45^a	4.26 ± 0.47^a	26.38 ± 2.78^a
Purple corn	Pan with oil	2.44 ± 0.32^a	3.72 ± 0.16^b	27.03 ± 3.69^a
	Electrical popper without oil	2.81 ± 0.51^a	3.11 ± 0.64^c	23.71 ± 2.38^b
	Electrical popper with oil	2.78 ± 0.08^a	4.15 ± 0.80^a	26.33 ± 0.75^a

Mean ± Standard deviation, Different letters in each column indicate statistically significant ($P \leq 0.05$) difference between all forms for both type.

The data of flake size and expansion volume for yellow and purple popcorn expanded by three different methods showed statistically significant ($P \leq 0.05$). Table (4) shows that the average of flake size varies from 4.26 Cm^3 for yellow popcorn expanded by electric popper with oil to 3.11 cm^3 for purple popcorn expanded by electric popper without oil. The highest value of expansion volume (26.38 Cm^3/g) recorded for yellow popcorn expanded by electric popper with oil, this value has no significant deference with that recorded for purple popcorn expanded by electric popper with oil (26.33 Cm^3/g). These results are in good agreements with those of Song *et al*. (1991), who showed that middle-sized kernels had the highest expansion volume by oil popping. Yellow popcorn expanded by electrical popper without oil had the lowest value of expansion volume (23.22 Cm^3/g). Data in Table (4) reveal that the expansion volume of yellow and purple popcorn popped by the same method were comparable, but significantly different from those expanded with and without oil. The expansion volume increased as the number of unpopped kernels decreased for both type in all treatments under study. Ceylan and Karababa (2004) reported that the high expansion corn is desirable for both the consumer and the manufacturer. For the consumer, increasing volume means easy chewing and more. For a commercial, expansion volume can have a direct effect on the profitability of the operation. Operator buys popcorn by weight and sells it by volume (full box or bag). High expansion volume translates directly to increased profitability. Each percentage point of increased expansion is a reduction in raw material cost.

CONCLUSION

The effect of three popping methods (pan with oil, electrical popper with and without oil) was studied for yellow and purple popcorn. The results showed that the purple popcorn is suitable and perfect for popping and eating just like regular yellow popcorn for producing popcorn. Popping with oil is better than popping without oil for both yellow and purple popcorn. The expansion volume of yellow and purple popcorn made by the same expansion method was not significant, but significantly different from those expanded with oil and expanded without oil. The expansion volume increased as the number of unpopped kernels decreased for both type in all popping methods.

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التقييم الحسي والغذائي وجودة الفشار للذرة الصفراء والارجوانية

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الهدف من هذا البحث هو تقييم الخصائص الحسية والغذائية وكفاءة التفرقع لنوعين من الذرة هما الفشار الصفراء والارجوانية باستخدام طرق التفرقع الاتية : في مقلاة مع الزيت، في ماكينة كهربائية في وجود الزيت أوفي ماكينة كهربائية بدون زيت. وجد ان الفشار الأرجوانية اعلى في محتوى البروتين (12.56٪)، والألياف الخام (3.58٪)، والرماد (1.89٪)، في حين أن الفشار الصفراء يحتوي على 10.84٪، 2.27٪، 1.03٪ للبروتين والألياف الخام والرماد على الترتيب. واتضح أن أعلى تقبل بواسطة المحكمين كان للفشار الناتج من الماكينة الكهربائية في وجود الزيت، مع عدم وجود اختلاف معنوي بين الفشار الصفراء والارجوانية الناتج بنفس الطريقة. أشارت النتائج الى ارتفاع محتوى الكاروتينات عند التفرقع في وحود الزيت وانخفاض المحتوى عند التفرقع بدون الزيت في النوعين بالمقارنة بمحتوى الكاروتينات في الحبوب قبل التفرقع. وجد أعلى محتوى من الأنثوسيانين وجد في الفشار الأرجواني قبل التفرقع، وانخفضت القيمة بعد التفرقع بالطرق المختلفة. احتوت حبوب الفشار الصفراء والأرجوانية على 1.19 و 1.58 مجم حمض الجاليك / جم على الترتيب، وزاد بشكل ملحوظ محتوى الفينولات الكلية بعد التفرقع في مقلاة مع زيت في كل من الفشار الصفراء والارجوانية. لم يكن هناك فرق معنوي في حجم التفرقع للفشار الصفراء والارجوانية عند اعدادهم نفس طريقة التفرقع ، ولكن اختلف حجم التفرقع معنويا بين الفشار المفرقع في وجود زيت والفشار المفرقع بدون زيت.