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The effect of alkaline salts and peanut skin extract on the qualitative attributes of fried coated peanuts and the frying oil

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ABSTRACT

The aim of this study was to see how alkaline salts of sodium carbonate and potassium carbonate, as well as peanut skin extract, affected the qualitative qualities of fried coated peanuts during shelf life, as well as the chemical properties of the oil used in the frying process.Control coated peanuts with no alkaline salts or peanut skin extract, as well as additional samples with varying percentages of two alkaline salts, sodium carbonate (0.10, 0.12, 0.14) and potassium carbonate (0.16, 0.18, and 0.20) next to each other or along with 0.02% peanut skin extract. Following the production of samples, the peroxide and anisidine indices, oil absorption rate, colorimetry, and sensory assessment of peanuts were assessed. The utilized oil's iodine, soap, peroxide, anisidine values, polar compounds, and acidity were also studied. The addition of alkaline salts reduced oil absorption in peanuts significantly ($p < 0.05$). Lower peroxide and anisidine values were detected in samples containing peanut skin extract in addition to alkaline salts ($p < 0.05$). Increasing the concentration of alkaline salts significantly led to a decrease in brightness, an increase in redness, yellowness, and ΔE in coated peanut samples ($p < 0.05$). The sensory evaluation scores decreased as the concentration of alkaline salts increased, but the use of concentrations of 0.10% sodium carbonate and 0.16% potassium carbonate significantly improved texture crispness and overall acceptability compared to the control ($p < 0.05$). There was no significant difference in other sensory indications as compared to the control. Chemical analysis of used frying oil revealed the same results for all samples, and alkaline salts and peanut skin extract had no effect on the oil's quality. The iodine and soap values of the oils used to fry all peanut samples declined, whereas acidity, peroxide and anisidine values increased. According to the results, it was proposed to coat peanuts in the frying process with 0.10% sodium carbonate, 0.16% potassium carbonate, and 0.02% peanut skin extract.

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1. Introduction

Peanut with scientific name*Arachis Hypogaea* It is an annual plant from the Leguminosae family, which has the capacity to become perennial if it is in frost-free areas [1]. This product contains compounds such as fiber, protein, unsaturated fat, various vitamins and polyphenol [2]. Peanut is a food with high nutritional value, which contains 36 to 54% of oil, 16 to 36% of protein and 10 to 20% of carbohydrates. High nutritional value and easy digestion are the features that have made this product known as one of the most consumed nuts, besides, peanuts are a rich source of minerals and various vitamins [3]. Since peanuts contain large amounts of unsaturated fatty acids, one of the important reasons for its spoilage is the oxidation of fat that occurs during the storage period of roasted peanuts [4].

In addition to the brain, peanuts also have soft skin and hard skin, which remain after processing peanuts in a large amount and are used as agricultural waste, for animal feed and fertilizer. The soft skin of peanuts is pink in color and has a gassy taste and is usually removed before eating the peanuts. Research shows that the soft skin of peanut is rich in antioxidant and phenolic compounds and its extract inhibits the oxidation of fats [5].

Frying is a key step in the production process of nuts, nuts and dried fruit and causes physical, chemical, structural and sensory changes in the processed seed [6]. During the frying process, the food is immersed in oil and placed at high temperature for a long period of time in the presence of air oxygen and moisture [7]. Coated peanuts are produced by frying [8].

Among the methods of increasing the shelf life of peanuts, we can mention the use of coating and covering the product with different compounds [5, 9, 10]. Edible coatings are used to improve food quality, increase shelf life and reduce waste [11]. Coating peanuts preserves the sensory properties of roasted peanuts [10]. Martin et al. (2019) evaluated the chemical and sensory properties of roasted peanuts using low-fat, high-protein peanut flour (DPF) coatings with and without antioxidants. DPF coatings delayed the oxidation of roasted peanuts and increased their sensory properties and shelf life compared to uncoated roasted peanuts [12]. The results of Rossi-Márquez et al. (2021) showed that whey-pectin protein coatings are a promising combination for increasing the shelf life of roasted peanut kernels using natural ingredients [13]. The results of Habibi and Hosseini (2022) also indicated that chitosan nanoparticle with a concentration of 1.5% is a suitable substance to be used as an edible coating in nuts, including peanuts, in terms of antioxidant properties [14].

Sodium carbonate and calcium carbonate salts are types of alkaline salts, the addition of which can affect the sensory and physicochemical quality of the product. Today, alkaline salts such as sodium carbonate and calcium carbonate are used in various industries to improve quality[15]. The results of Fan et al. (2018) indicated that the use of alkaline salts in noodles reduced the content of free sulfhydryl (SH), increased hardness and significantly reduced adhesion, and no significant change was observed in the elasticity of noodles. [15]. LeMaster et al. (2019) studied the effect of replacing sodium tripolyphosphate with potassium carbonate in meat. The results showed that potassium carbonate improved the quality properties and increased the red color and reduced the cooking loss and increased the sensory properties of the product [16]. Also, the use of sodium carbonate in chicken meatballs as a substitute for phosphate was associated with positive effects on product quality[17].

According to the research conducted so far, there has been no research on the effect of alkaline salts along with peanut skin extract on the quality characteristics of coated peanuts.

Therefore, the aim of this study was the effect of alkaline salts and peanut skin extract on the physicochemical and sensory characteristics of fried coated peanuts during the storage period and also the chemical characteristics of the oil used in the frying process.

2- Materials and methods

2-1- Materials

The used Iranian raw type of peanut was Astana crop of 1400-1401. Alkaline salts of sodium carbonate and potassium carbonate were obtained from Sinapjoh Pars Company, salt and sugar from Gostan Company and Ard Nol flour with an extraction degree of 42% were obtained from Asal Khawan Company. The used palm olein oil was imported from Malaysia in 2022. Other chemicals were obtained from Merck, Germany.

2-2 Preparation of peanut skin extract

Extraction of peanut skin was done by water-alcohol method. For this purpose, the peanut skin was dried and turned into a fine powder of 0.5 mm using a grinder, then half a gram of the ground sample was added to tubes containing 80% ethanol and water in a ratio of 50:50, and then the samples were placed on a shaker. It was placed at a temperature of 25 degrees Celsius for 24 hours. Then filtered extracts (by Whatman filter) were centrifuged at 1500 rpm for 10 minutes. In the next step, ethanol was separated from the extract by rotary and the extract was stored in a refrigerator at 4 degrees Celsius until use [2, 18].

2-3 Chemical tests of peanut skin extract

2-3-1-test to determine total phenol content

Determination of the total phenolic content of peanut skin extract was investigated using Folin-Ciocalto assay protocol and according to the method of Christman (2010). The absorption value of the solution was read by a Philler scientific spectrophotometer made in the United States at a wavelength of 765 nm. Total phenol content was expressed as mg of gallic acid per gram of dry weight [5].

2-3-2 antioxidant activity test

DPPH radical scavenging method was performed on the samples according to the method of Christman (2010). Absorbance values after 90 minutes were read at 515 nm wavelength using Philler scientific spectrophotometer made in America. DPPH radical inhibition percentage was calculated using equation 1 [5].

equation (1) $DPPH = \frac{AC-MP}{AC} \times 100$

AC= without addition of DPPH sample, absorbance of solution AS= after addition of DPPH sample, absorbance of solution

2-4- Preparation of coated peanut samples

At first, a solution containing 20% sugar, 2% sodium salt, various percentages of alkaline salts of sodium carbonate and potassium carbonate, peanut skin extract (according to Table 1) and water was prepared and added to the coated peanut formulation.

To produce coated peanuts by frying, first the peanuts were poured into special rotating cylinders called dragees and the solution prepared for each sample was sprinkled on it. Then, null flour with an extraction degree of 42% was poured and the peanuts were covered while rotating. The rotation time was 15 minutes and the speed of the cylinder was 6 revolutions per minute. Then, the control and treated peanut samples were fried inside the fryer with palm olein oil at 150 degrees Celsius for 10-15 minutes. The samples were stored for 120 days in metalized packaging with nitrogen injection with a purity of at least 92% at room temperature and away from sunlight.

25-Extraction of coated peanut oil

To 50 g of the homogenized sample, some hexane was added to completely cover it. After mixing and keeping for 24 hours until the solvent phase became clear, the clarified phase was smoothed with filter paper and then evaporated using a rotary solvent device. After that, the remaining oil was used for different tests.

6- 2- coated peanut tests

2-6-1 Physicochemical tests

The amount of oil absorption of the samples after frying on the first day of production was determined by the Soxhlet method (according to the AOAC 2003.05 standard) in three replicates. Determination of peroxide index (according to AOAC standard 965.33) [19] and anisidine number (according to Iranian national standard No. 4093) [20] for peanut samples during the 120-day storage period (days 1, 30, 60, 90 and 120) It was done in three repetitions.

2-6-2 Colorimetry test

The color test of the samples was done on the first day and in 3 repetitions. The color of the peanut samples was evaluated by Huntlab ColorFlex EZ 0.45 machine made in Australia and the brightness indices (L*, red-green (a*) and yellow-blue (b*) were measured. Also, the overall color changes (ΔE) which represent the color changes of the samples compared to the control was determined from equation 2 [21, 22].

Equation (2) $\Delta E = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$

2-6-3 Sensory test

10 trained evaluators and scoring method (2, 3, 4, 5 and 1 respectively for very good, good, average, bad and very bad) were used to evaluate the sensory characteristics. The factors of taste, smell, color, texture crispness and overall acceptability were investigated.

2-7 Chemical tests of used oil

The chemical tests of the oil include the determination of iodine number (according to AOAC standard 993.20) [19], soap number (according to AOAC standard 920.81) [19], peroxide number (according to AOAC standard 965.33) [19], anisidine number (according to the Iranian national standard no. 4093) [20] and acidity (according to AOAC standard 969.17) [19]. The amount of polar compounds was measured using the Testo method. The analysis was done by placing the sensor inside the preheated oil (temperature above 100 degrees Celsius) and the temperature and the content of polar compounds in percent were read on the screen after about 30 seconds [23]. Tests were performed before and after 8 hours of continuous frying of peanuts (one work shift in one day) on used oil in three replications.

8-2 Statistical analysis

All experiments were conducted in a completely randomized design with 3 replications. The analysis was performed using SPSS version 26 software at the level of 5% error probability. LSD analysis of variance was used to compare means.

3. Results and Discussion

1-3- The results of coated peanut tests

3-1-1- The results of the absorption rate test of coated peanut oil

The results of oil absorption of peanut samples are shown in Figure 1. The samples to which alkaline salts were added had significantly less fat content than the control sample ($p < 0.05$). P4 treatment (coated peanuts containing 0.14% sodium carbonate solution and 0.20% potassium carbonate) and P7 (coated peanuts containing 0.14% sodium carbonate solution and 0.20% potassium carbonate and 0.02% peanut skin extract)They significantly had the lowest oil absorption rate, which indicates that the increase in the percentage of alkaline salts in the samples caused a further decrease in the oil absorption rate.

The difference between treatments without peanut skin extract and treatments with peanut skin extract and the same concentration of alkaline salt was not significant, so peanut skin extract did not play a role in reducing oil absorption. Edible coatings can control the migration of moisture, gases, lipids and the growth of microbes. [24]. Pranoto and Marseno (2009) evaluated the effects of two types of cellulose film derivatives, including methyl cellulose and hydroxypropyl methyl cellulose, in increasing the stability of peanuts. In this study, it was found that the oil absorption of the coated samples was significantly lower than the control sample [25].

Salehi (2020) concluded that the use of different gums as hydrocolloid coatings reduced the heat transfer coefficient and reduced oil absorption during the deep frying process of products such as eggplant, potato, carrot, banana, cereal products and shrimp [26].

In the current research, the use of a coating with alkaline salts has caused more hindrance in oil absorption by peanut samples because alkaline salts cause the texture to be hard due to the strong protein bonds it creates, and the hard texture causes less oil absorption.

3-1-2 Results of peroxide and anisidine index tests

The results of the peroxide and anisidine tests in Tables 2 and 3 indicate that the peroxide and anisidine index in all treatments containing alkaline salts and peanut skin extract was significantly lower than the control sample and the samples containing alkaline salts (<0.05). p). Treatments P5, P6, and P7 had the lowest amount of peroxide and anisidine index in all days, and the treatments without peanut skin extract had no significant difference with the control. This shows that peanut skin extract was effective in reducing oxidation and alkaline salts did not have an effective role in reducing these indices.

The reduction of peroxide and anisidine index can be attributed to the presence of antioxidant compounds such as phenols in peanut skin. The study conducted by Yu and his colleagues in 2005 showed that in peanut skin extract, phenolic compounds such as phenolic acids, flavonoids and Resveratrol stilbene[1] There are [27].

[1]- Stilbene-resveratrol

Phenolic compounds in plants, due to their hydroxyl groups, have the ability to donate hydrogen or electrons to neutralize radicals and are known as a group of strong antioxidants, and with an increase in their amount, its antioxidant properties increase [28].

The results of total phenol content and antioxidant activity of peanut skin extract of the present study were 3261 mg GAE/g DW and 73.41%, respectively. In other researches, the antioxidant property of peanut skin extract and its effect in reducing the oxidation of different products have been stated. Yu et al. (2010) investigated the potential of peanut skin extract as an inhibitor of fat oxidation in cooked and raw ground beef. The results showed that the addition of peanut skin extract to raw ground beef before cooking significantly inhibited the formation of peroxides and reactive compounds with thiobarbituric acid in cooked ground beef during refrigerated storage [18].

Christman et al. (2018) using encapsulated peanut skin phenolic extract in a flavor coating for peanuts concluded that the total phenolic content and antioxidant capacity were significantly higher than control peanuts [5].

Oxidation can cause an unpleasant taste and smell in peanuts and products made from them during storage, which in advanced stages makes these materials lack the necessary quality for human nutrition [29]. Peroxides and hydroperoxides are the primary products of oxidation, and the peroxide index indicates the amount of peroxide and hydroperoxide formed in peanuts. Anisidine index also indicates the amount of secondary products formed during oxidation in peanuts. The secondary oxidation products include aldehydes, ketones, alcohols, hydrocarbons, volatile organic acids and epoxy compounds [30]. During the storage period, peroxide and anisidine index of coated peanut samples increased. The increasing trend of these indices is related to the acceleration of oxidation during the storage stage [31, 32]. It is worth noting that the increasing trend of peroxide and anisidine index during the storage period for samples containing alkaline salts along with peanut skin extract was lower than other samples.

3-1-3 Colorimetry test results of coated peanuts

The colorimetric results in Table 4 show that increasing the concentration of alkaline salts significantly led to a decrease in brightness, an increase in redness, yellowness and ΔE index in coated peanut samples ($p < 0.05$).

In this study, no significant difference was observed between the color indices of treatments without extract and treatments with extract and the same concentration of alkaline salts. Therefore, compared to alkaline salts, the extract did not have an effective role on color indicators.

Alkaline salts produce a darker color [33]. Therefore, the main reason for the decrease in brightness and the increase in redness and yellowness of treatments containing alkaline salts compared to the control sample was the presence of alkaline salts.

LeMaster et al. (2019) investigated the effect of potassium carbonate instead of sodium tripolyphosphate on the quality properties of fresh meat and observed that potassium carbonate improved the quality properties, increased the red color of the meat and reduced the yellowness in the final product [16].

In a study, Oztürk and Serdaroğlu (2019) investigated the quality of chicken meatballs produced with artichoke powder alone or in combination with sodium carbonate as a substitute for sodium tripolyphosphate. The results of colorimetry showed that the use of sodium carbonate alone in the formulation of chicken meat resulted in the highest L* and b* and the lowest a* amount compared to the use of artichoke powder alone or together with sodium carbonate [17].

3-1-4- Sensory evaluation test results

The results of sensory evaluation are shown in Table 5. Treatments P2 and P5 obtained the highest score in the evaluation of color, smell, taste, texture crispness and overall acceptability among the treatments with alkaline salts in all days. The score of texture crispness and acceptability of P2 and P5 treatments were higher than the control treatment in all days. With the increase in the concentration of alkaline salts, a decreasing trend was observed in the sensory indices. In evaluating texture crispness and overall acceptability, treatments P4 and P7 scored the lowest in all days, so the score of sensory indicators was dependent on the concentration of alkaline salts used, and the use of lower concentrations of alkaline salts had a positive effect on the sensory characteristics of peanut treatments. Therefore, due to the non-significance of treatments P2 and P5, as well as P4 and P7, it can be concluded that peanut extract did not have a significant effect on sensory index and the presence of alkaline salts caused changes in sensory scores.

Oztürk and Serdaroğlu (2019) by examining the quality of chicken meatballs produced with artichoke powder alone or in combination with sodium carbonate as a substitute for sodium tripolyphosphate, stated that in the sensory evaluation, adding a medium percentage of the composition of sodium artichoke powder has the best effect on the indicators. It had a feeling [17]. In another study, the use of potassium carbonate in meat also increased sensory properties and was accepted by consumers [16].

In the present research, since the treatments were in metallized packaging, there was no sensory difference over time in most cases because metallized packaging prevents spoilage factors such as light, heat, moisture, oxygen, microorganisms, and pollution [34].

2-3- The results of chemical tests of used oil before and after frying

The results of chemical tests of used oil were the same for all treatments, as shown in Table 6. Treatments containing alkaline salts, as well as treatments containing alkaline salts and peanut skin extract, had no effect on changing the frying oil indices. Among the reasons for the uniformity of the results of chemical tests and the lack of effect of alkaline salts and extract, we can mention the small volume of peanuts compared to the large volume of oil. Because 50 kg of peanuts were poured into 800-1000 liters of oil and frying was done. Another reason for the same results can be attributed to the coating of peanuts, that the hardness of the coating prevented alkaline salts and peanut skin extract from seeping into the oil. The iodine index of the oil decreased significantly after frying ($p < 0.05$). The iodine number is a measure of the number of double bonds in the oil, and the reduction of the iodine number in the oil after frying indicates its saturation and sourness [34]. The gradual decrease in the unsaturation of oils can be attributed to the destruction of double bonds by oxidation and polymerization [35]. In the preliminary stage of oxidation, the free radicals formed by attacking the double bond site cause displacement of the double bond [36] and according to the Diels-Elder reaction, in the advanced stages of oxidation, they turn into polymer compounds and secondary products of oxidation [37]. The results of the oil soap index test before and after frying showed that there was a statistically significant difference in the soap index ($p<0.05$) and it decreased after frying.

Soap number is considered as one of the identification characteristics of different types of oils and shows the average molecular weight or chain length of the fatty acids that make up the oil [38]. The reduction of the soap index in the oil after frying can be related to the polymerization of the oil by heat. In polymerization, oil molecules react with each other and form longer chains than the original oil, which reduces the soapy index [39].

In 2019, Daryai et al. studied the effect of temperature and processing method on the chemical, sensory and shelf life characteristics of packaged sunflower seeds. The results showed that there was no significant change in the soap number of sunflower seed oil at temperatures between 150-190 degrees Celsius [40].

The polar compounds of the oil increased significantly before and after frying ($p < 0.05$). Polar compounds include a set of compounds resulting from the processes of oxidation, polymerization and hydrolysis of fatty molecules such as free fatty acids, mono and diacylglycerols, aldehydes, ketones, dimers, trimers, etc. Therefore, even in freshly extracted oil, polar compounds may be more or less present [41].

The results of oil acidity test before and after frying showed that there was a statistically significant difference in acidity ($p<0.05$) and it increased after frying. The increase in acidity during the heating process at high temperature can be attributed to the role of high temperature in accelerating the separation of fatty acid from fat molecules, or in other words, facilitating the mixing of the water of the fried food and the frying oil under these conditions. In addition, free fatty acids themselves are able to emulsify water and oil due to their emulsifying properties and intensify the dehydration process and ultimately increase the number of free fatty acids [41]. The peroxide and anisidine index of the oil increased significantly before and after frying ($p < 0.05$). Over time, primary oxidation products turn into secondary products. [41]. The anisidine number is known as an indicator of secondary oxidation products [42] and the effective factor in increasing the anisidine number during oil heating is the formation of aldehyde [34].

4 - Conclusion

Based on the obtained results, it can be concluded that the use of different concentrations of alkaline salts and the presence of peanut skin extract had a significant effect on the qualitative characteristics of fried coated peanuts, but the type of treatments did not affect the chemical characteristics of the used oil. Considering the good results of P2 and P5 peanut samples in the sensory evaluation and the lower peroxide index and anisidine index of P5 sample compared to P2 and due to the presence of peanut skin extract, the concentration of 0.10% sodium carbonate and 0.16% potassium carbonate was used. Along with 0.02% of peanut skin extract, it is recommended to coat peanuts in the frying process.

5- Thanksgiving

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7- Attachments

Table 1 the percentage of alkaline salts and peanut skin extract used in peanut samples

Sample	Sodium carbonate(%)	Potassium carbonate(%)	Peanut skin extract
P_1	0	0	0
P_2	0.10	0.16	0
P_3	0.12	0.18	0
P_4	0.14	0.20	0
P_5	0.10	0.16	0.02
P_6	0.12	0.18	0.02
P_7	0.14	0.20	0.02

Table 2 peroxide values of peanut samples during storage

Sample/Time	Peroxide value (meq/kgO_2)				
	Day 1	Day 30	Day 60	Day 90	Day 120
P1	2.3 ± 0.15^{Yes}	3.78 ± 0.20^{And}	5.71 ± 0.26^{That}	7.06 ± 0.06^{Not}	7.72 ± 0.25^{Aa}
P2	2.34 ± 0.11^{Yes}	3.7 ± 0.23^{And}	5.7 ± 0.26^{That}	7.08 ± 0.06^{Not}	7.75 ± 0.10^{Aa}
P3	2.27 ± 0.06^{Yes}	3.57 ± 0.27^{And}	5.7 ± 0.18^{That}	7.15 ± 0.16^{Not}	7.73 ± 0.24^{Aa}
P4	2.31 ± 0.17^{Yes}	3.68 ± 0.22^{And}	5.59 ± 0.30^{That}	7.07 ± 0.14^{Not}	7.6 ± 0.12^{Aa}
P5	1.28 ± 0.18^{Db}	2.38 ± 0.23^{Cb}	3.57 ± 0.37^{Bb}	4.04 ± 0.19^{Ab}	4.25 ± 0.35^{Ab}

P6	1.25±0.25^{Db}	2.06±0.10^{Cb}	3.54±0.57^{Bb}	4.04±0.29^{Ab}	4.3±0.39^{Ab}
P7	1.36±0.27^{Db}	2.27±0.23^{Cb}	3.45±0.14^{Bb}	3.95±0.32^{Ab}	4.31±0.19^{Ab}

P1(control): without alkaline salts and peanut skin extract. P2, P3, and P4: without peanut skin extract and contain 0.10, 0.12, and 0.14% of sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. P5, P6, and P7: contain 0.02% peanut skin extract, 0.10, 0.12, and 0.14% sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. Results are presented as a mean value ± SD .The different superscript lowercase and uppercase letters are significant ($p < 0.05$) in each identical column and row respectively.

Table 3 anisidine values of peanut samples during storage

Sample/Time	Anisidine value				
	Day 1	Day 30	Day 60	Day 90	Day 120
P1	3.61±0.26^{That}	4.03±0.07^{BCa}	4.64±0.22^{Not}	5.49±0.52^{Aa}	6±0.21^{Aa}
P2	3.56±0.39^{That}	4.02±0.38^{That}	4.82±0.17^{Not}	5.4±0.46^{ABa}	5.94±0.29^{Aa}
P3	3.48±0.47^{That}	3.96±0.34^{BCa}	4.56±0.54^{Not}	5.53±0.67^{Aa}	5.85±0.78^{Aa}
P4	3.56±0.31^{That}	3.98±0.20^{BCa}	4.62±0.45^{Not}	5.41±0.48^{Aa}	5.9±0.32^{Aa}
P5	2.37±0.12^{Cb}	3.02±0.22^{BCb}	3.66±0.09^{Bb}	4.72±0.63^{Ab}	5.1±0.36^{Ab}
P6	2.33±0.05^{Cb}	2.96±0.18^{Cb}	3.66±0.11^{Bb}	4.69±0.64^{Ab}	4.94±0.40^{Ab}
P7	2.27±0.17^{Cb}	2.96±0.53^{Bb}	3.46±0.22^{Bb}	4.58±0.57^{Ab}	4.92±0.66^{Ab}

P1(control): without alkaline salts and peanut skin extract. P2, P3, and P4: without peanut skin extract and contain 0.10, 0.12, and 0.14% of sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. P5, P6, and P7: contain 0.02% peanut skin extract, 0.10, 0.12, and 0.14% sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. Results are presented as a mean value ± SD.The different superscript lowercase and uppercase letters are significant ($p < 0.05$) in each identical column and row respectively.

Table 4 color values of peanut samples

Sample	L*	a*	b*	ΔE
P1	72±2.646^{a}	4.27±0.153^{c}	3.23±0.306^{b}	---
P2	68.67±3.512^{ab}	5.14±0.029^{bc}	3.54±0.471^{b}	4.22±2.482^{c}
P3	57.67±3.055^{c}	5.7±0.494^{b}	4.34±0.186^{a}	14.46±1.450^{b}
P4	48.33±3.055^{d}	9.82±1.15^{a}	5.09±0.705^{a}	24.43±2.815^{a}
P5	67.13±2.579^{b}	5.14±0.137^{bc}	3.36±0.307^{b}	5.05±4.505^{c}
P6	56.4±1.213^{c}	5.75±0.579^{b}	4.39±0.211^{a}	15.72±2.199^{b}
P7	49.46±2.151^{d}	9.63±1.173^{a}	5.07±0.593^{a}	23.29±2.024^{a}

P1(control): without alkaline salts and peanut skin extract. P2, P3, and P4: without peanut skin extract and contain 0.10, 0.12, and 0.14% of sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. P5, P6, and P7: contain 0.02% peanut skin extract, 0.10, 0.12, and 0.14% sodium carbonate, and 0.16, 0.18, and 0.20%

potassium carbonate, respectively. Results are presented as a mean value ± SD. The different superscript letters are significant in the same column ($p<0.05$).

Table 5 The sensory evaluation of peanut samples during storage

Sensory parameters	Sample/Time	Standard deviation±Mean				
		Day 1	Day 30	Day 60	Day 90	Day 120
Color	P1	4.67 ± 0.58^{Aa}	4.33 ± 0.58^{ABa}	4.33 ± 0.58^{ABab}	4.33 ± 0.58^{ABa}	3.67 ± 0.58^{Chapter}
	P2	5 ± 0^{Aa}	5 ± 0^{Aa}	4.67 ± 0.58^{Aa}	4.67 ± 0.58^{Aa}	4.33 ± 0.58^{Aa}
	P3	3.67 ± 1.15^{Ab}	3.33 ± 0.58^{Ab}	3.67 ± 0.58^{Ab}	3.33 ± 0.58^{Ab}	3.33 ± 0.58^{Ab}
	P4	2 ± 0^{And}	1.67 ± 0.58^{And}	1.33 ± 0.58^{And}	1.33 ± 0.58^{And}	1.33 ± 0.58^{And}
	P5	5 ± 0^{Aa}	5 ± 0^{Aa}	5 ± 0^{Aa}	4.67 ± 0.58^{Aa}	4.33 ± 0.58^{Aa}
	P6	3.67 ± 1.15^{Ab}	3.33 ± 0.58^{Ab}	3.67 ± 0.58^{Ab}	3.33 ± 0.58^{Ab}	3.33 ± 0.58^{Ab}
	P7	2 ± 0^{And}	1.33 ± 0.58^{And}	1.33 ± 0.58^{And}	1.33 ± 0.58^{And}	1.67 ± 0.58^{And}

	P1	4.67±0.58^{Oops}	4.67±0.58^{Aa}	4.67±0.58^{Aa}	4.33±0.58^{Oops}	4.67±0.58^{Aa}
	P2	5±0^{Aa}	5±0^{Aa}	4.67±0.58^{Aa}	5±0^{Aa}	5±0^{Aa}
	P3	3.33±0.58^{Acd}	3.33±0.58^{Ab}	3.67±0.58^{Ab}	3.67±1.15^{Abc}	3.67±0.58^{Ab}
	P4	3±0^{USA}	2±0^{Cc}	3.33±0.58^{Ab}	3±0^{ABc}	2.33±0.58^{BCc}
	P5	5±0^{Aa}	5±0^{Aa}	4.67±0.58^{Aa}	5±0^{Aa}	5±0^{Aa}
	P6	4±0^{Abc}	3.33±0.58^{Ab}	4±1^{Oops}	3.67±1.15^{Abc}	3.67±0.58^{Ab}
	P7	3±0^{USA}	2±0^{Cc}	3.33±0.58^{Ab}	3.33±0.58^{And}	2.33±0.58^{BCc}
Taste	P1	5±0^{Aa}	4.67±0.58^{Aa}	4.33±0.58^{Aa}	4.67±0.58^{Aa}	4.33±0.58^{Oops}
	P2	5±0^{Aa}	5±0^{Aa}	4.67±0.58^{Aa}	5±0^{Aa}	4.67±0.58^{Aa}
	P3	4±0^{Ab}	3.67±1.15^{Ab}	3.33±0.58^{Ab}	3.33±0.58^{Ab}	3.67±0.58^{Ab}
	P4	4±0^{Ab}	3±0^{Aa}	3.33±0.58^{ABb}	3.67±0.58^{ABb}	3.67±0.58^{ABb}
	P5	5±0^{Aa}	5±0^{Aa}	5±0^{Aa}	5±0^{Aa}	4.67±0.58^{Aa}
	P6	4±0^{Ab}	3.67±1.15^{ABb}	3±1^{Bb}	3.33±0.58^{ABb}	4±0^{Oops}
	P7	3.67±0.58^{Ab}	3±0^{Ab}	3.33±0.58^{Ab}	3.67±0.58^{Ab}	3.67±0.58^{Ab}
Crispiness	P1	2.33±0.58^{Ab}	2.67±0.58^{Ab}	2.67±0.58^{Ab}	2.67±0.58^{Ab}	3±0^{Ab}
	P2	4±1.73^{Aa}	4.67±0.58^{Aa}	4.67±0.58^{Aa}	4.67±0.58^{Aa}	5±0^{Aa}
	P3	1.67±0.58^{Abc}	2.33±0.58^{Abc}	2±0^{Abc}	2±0^{Abc}	1.67±0.58^{And}
	P4	1±0^{And}	1.67±0.58^{And}	1.33±0.58^{And}	1.33±0.58^{And}	1±0^{And}
	P5	4±1.73^{Aa}	4.67±0.58^{Aa}	4.67±0.58^{Aa}	4.67±0.58^{Aa}	5±0^{Aa}
	P6	1.67±0.58^{Abc}	2.33±0.58^{Abc}	2±0.58^{Abc}	2.33±0.58^{Ab}	1.67±0.58^{And}
	P7	1±0^{And}	1.67±0.58^{And}	1.33±0.58^{And}	1.33±0.58^{And}	1.33±0.58^{And}
Overall Acceptance	P1	3.33±0.58^{Ab}	3.67±0.58^{Ab}	3.33±0.58^{Ab}	3.67±0.58^{Ab}	3.67±0.58^{Ab}
	P2	4.33±1.15^{Aa}	4.67±0.58^{Aa}	4.33±0.58^{Aa}	5±0^{Aa}	4.67±0.58^{Aa}
	P3	2.67±0.58^{Ab}	3±0^{Ab}	3±0^{Abc}	3.33±0.58^{Ab}	3±0^{Ab}
	P4	1.67±0.58^{And}	1.67±0.58^{And}	2.33±0.58^{And}	2±1^{And}	1.67±0.58^{And}
	P5	4.33±1.15^{Aa}	4.67±0.58^{Aa}	4.67±0.58^{Aa}	5±0^{Aa}	4.67±0.58^{Aa}
	P6	2.67±0.58^{Ab}	3±0^{Ab}	3±0^{Abc}	3.33±0.58^{Ab}	3±0^{Ab}
	P7	1.67±0.58^{And}	1.67±0.58^{And}	2.33±0.58^{And}	2±1^{And}	1.67±0.58^{And}

P1(control): without alkaline salts and peanut skin extract. P2, P3, and P4: without peanut skin extract and contain 0.10, 0.12, and 0.14% of sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. P5, P6, and P7: contain 0.02% peanut skin extract, 0.10, 0.12, and 0.14% sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. Results are presented as a mean value ± SD. The different superscript lowercase and uppercase letters are significant ($p < 0.05$) in each identical column and row respectively for each sensory value.

Table 6 Comparison of chemical properties of used oil before and after frying

Parameter	Standard deviation±Mean	
	Before frying	After frying
Iodine value	0.058^{a}±22.53	0.49^{b}±16.78
Saponification value (mg KOH/g oil)	1.52^{b}±247.67	3.05^{a}±234.33
(%)Polar compounds	0.98^{a}±11.29	1.17^{b}±20.38
(%)Acidity	0.002^{b}±0.03	0.73^{a}±5.4
Peroxide value (meq/kgO_2)	0.01^{b}±0.041	0.062^{a}±8.81
Anisidine value	0.02^{b}±2.02	0.044^{a}±51.85

The different superscript letters are significant in the same raw ($p<0.05$).

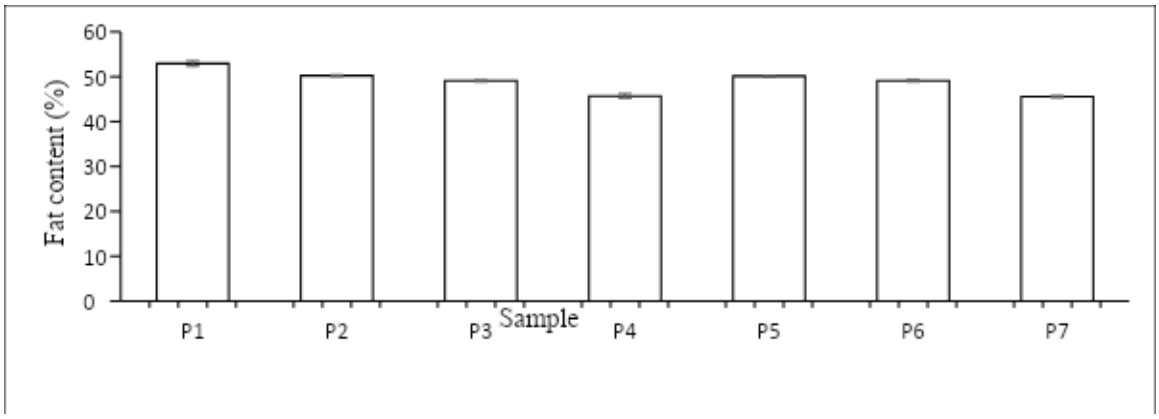

Fig 1 oil uptake of peanut samples during frying. P1(control): without alkaline salts and peanut skin extract. P2, P3, and P4: without peanut skin extract and contain 0.10, 0.12, and 0.14% of sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. P5, P6, and P7: contain 0.02% peanut skin extract, 0.10, 0.12, and 0.14% sodium carbonate, and 0.16, 0.18, and 0.20% potassium carbonate, respectively. Results are presented as a mean value ± SD. The different superscript letters are significant ($p<0.05$).

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مقاله علمی_پژوهشی

تأثیر نمک‌های قلیایی و عصاره پوست بادام‌زمینی بر ویژگی‌های کیفی بادام‌زمینی روکش‌دار سرخ‌شده و روغن استفاده‌شده در فرآیند سرخ‌کردن

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چکیده

هدف از این مطالعه بررسی تأثیر نمک‌های قلیایی کربنات سدیم و کربنات پتاسیم و عصاره پوست بادام‌زمینی بر ویژگی‌های کیفی بادام‌زمینی روکش‌دار سرخ‌شده در طول ماندگاری و نیز بر ویژگی‌های شیمیایی روغن مصرفی در فرآیند سرخ‌کردن بود. بادام‌زمینی روکش‌دار شاهد فاقد نمک‌های قلیایی و عصاره پوست بادام‌زمینی و نمونه‌های دیگر حاوی درصدهای مختلفی از دو نمک قلیایی کربنات سدیم (۰/۱۰، ۰/۱۲، ۰/۱۴) و کربنات پتاسیم (۰/۱۶، ۰/۱۸ و ۰/۲۰) در کنار یکدیگر و یا همراه با ۰/۰۲ درصد عصاره پوست بادام‌زمینی بودند. پس از تولید نمونه‌ها اندیس‌های پراکسید و آنیزیدین، میزان جذب روغن، رنگ‌سنجی و ارزیابی حسی بادام‌زمینی‌ها ارزیابی شد. همچنین اندیس‌های یدی، صابونی، پراکسید، آنیزیدین، ترکیبات قطبی و اسیدیته روغن مصرفی بررسی شد. افزودن نمک‌های قلیایی باعث کاهش معنادار جذب روغن در بادام‌زمینی شد($p <۰/۰۵$). در تیمارهایی که علاوه بر نمک‌های قلیایی دارای عصاره پوست بادام‌زمینی بودند اندیس پراکسید و اندیس آنیزیدین کمتری مشاهده شد($p <۰/۰۵$).افزایش غلظت نمک‌های قلیایی به طور معناداری منجر به کاهش روشنایی، افزایش قرمزی، زردی و شاخص ΔE در نمونه‌های بادام‌زمینی روکش‌دار شد($p <۰/۰۵$).با افزایش غلظت نمک‌های قلیایی روند کاهشی در امتیازهای ارزیابی حسی مشاهده شد اما استفاده از غلظت‌های ۰/۱۰ درصد کربنات سدیم و ۰/۱۶ درصد کربنات پتاسیم باعث بهبود معنادار تردی بافت و مقبولیت کلی نسبت به شاهد شد($p < ۰/۰۵$) و در سایر شاخص‌های حسی نیز تفاوت معناداری نسبت به شاهد ایجاد نشد. نتایج آزمون‌های شیمیایی روغن مصرفی بعد از سرخ‌کردن تمامی تیمارها یکسان شد و نمک‌های قلیایی و عصاره پوست بادام‌زمینی تأثیری در کیفیت روغن نداشتند. اندیس یدی و اندیس صابونی روغن‌های به‌کاررفته برای سرخ‌کردن تمام نمونه‌های بادام‌زمینی کاهش یافت و اسیدیته، اندیس پراکسید و اندیس آنیزیدین افزایش یافت($p <۰/۰۵$). باتوجه‌به نتایج حاصل شده، برای روکش‌دار کردن بادام‌زمینی در فرآیند سرخ‌کردن، استفاده از غلظت ۰/۱۰ درصد کربنات سدیم و ۰/۱۶ درصد کربنات پتاسیم به همراه ۰/۰۲ درصد عصاره پوست بادام‌زمینی پیشنهاد گردید.