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# Biofunctional effects of *Pistacia vera* addition on the quality of Simit Kebab

## *Biofunktionelle Wirkungen der Hinzufügung von Pistacia vera (Pistazien) auf die Qualität des türkischen Simit-Kebab*

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**Summary**

Important changes have taken place recently in consumer's preferences towards improving their health by ingesting functional food products enriched with bioactive compounds. The aim of this study was to investigate the functionalizing effects induced by the addition of pistachio nuts *(Pistacia vera (PV))* into simit kebab, a meat based product. Physicochemical properties (ph, dry matter, fat content and color values) and fatty acid composition analyses were carried out on raw simit kebab samples. Total phenolic content (TPC) and total antioxidant capacities (AC) analyses were carried out on both raw and cooked samples to determine the effects of cooking at 200°C/20min. Also, the storage influences (at 4°C/3 days) on the simit kebab were examined too. Significant differences in physicochemical properties were observed between the control and treated samples depending on both PV concentration and storage time ($p<0.05$). Color values of *L** and *a** in treated samples (7.5 and 10%) were significantly declined ($p<0.05$) in the course of storage when compared to the control samples. The TPC and AC in the treated samples showed a gradual and potential increase as the PV concentration increased. The values of TPC and DPPH inhibition ratio in 10% PV added samples were 33.60% and 53% higher than that expressed in the control samples, respectively. However, the storage period caused a reduction in both TPC and AC values of the raw samples. *PV* addition into simit kebab potentially increased the total polyunsaturated fatty acid (PUFA) concentration. Hence, data suggest that *Pistacia vera* is a good candidate of a new approach to functionalize and enhance nutritional properties of meat based products.

**Keywords:** Pistacia, Kebab, Pistacia vera, Antioxidans, Phenolic, Meat, food enrichment

**Zusammenfassung**

In letzter Zeit haben sich die Präferenzen der Verbraucher hinsichtlich der Verbesserung ihrer Gesundheit durch den Verzehr bestimmter Lebensmittelprodukte, denen bioaktive Inhaltsstoffe zugefügt wurden, erheblich verändert. Das Ziel dieser Studie ist es, die funktionalisierenden Wirkungen der Verwendung, bzw. Hinzufügung von *Pistacia vera* (Pistazien) auf Simit-Kebab, ein Fleischgericht, zu untersuchen. Die Analyse der physikalisch-chemischen Eigenschaften (pH-Wert, Trockenmasse, Fettgehalt und Farbwerte) und der Fettsäurezusammensetzung wurde an rohen Simit-Kebab-Proben durchgeführt. Der Gesamtphenolgehalt und auch die gesamte antioxidative Aktivität wurden sowohl an rohen als auch an gekochten Proben analysiert, um die Auswirkungen des Kochens bei 200°C für 20 Minuten festzustellen. Die Haltbarkeit wurde auch durch die Lagerung von Simit Kebab bei 4°C für bis zu drei Tagen untersucht. Bei den physikochemischen Eigenschaften wurden signifikante Unterschiede bezüglich der Pistazienkonzentration und der Lagerzeit beobachtet ($p <0,05$). Die Farbwerte von *L** und *a** in behandelten Proben (7,5 und 10%) waren im Laufe der Lagerung im Vergleich zu den Kontrollproben signifikant erniedrigt ($p <0,05$). An rohen, mit 7,5% bis 10% Pistazien angereicherten Proben stieg der Gesamtphenolgehalt auf 52% und 40% sowie die antioxidative Aktivität auf 24,49% und 34,69%. Die Hinzufügung von *Pistacia vera* (Pistazien) führte zu einem erheblichen Anstieg der Gesamtkonzentration an PUFA. Daher erwies sich der Zusatz von Pistacia vera (Pistazien) als guter Kandidat für einen neuen Ansatz zur Funktionalisierung von Fleischprodukten oder -gerichten.

**Schlüsselwörter:** Pistazien, Kebab, Pistacia vera, Antioxidant, Phenol, Fleisch, Lebensmittelanreicherung

## Introduction

Meat and meat based products and dishes such as; sucuk, pastirma, cigkofte and kebab take an important place in Turkish cuisine (Kilic, 2009). Kebab, a meat based dish, is one of the most consumed traditional cuisine and many different types of kebab are being prepared with various ingredients around Anatolia and southern parts of Turkey regions. Gaziantep Simit kebab is one of those kebab types which is famous for a city, called Gaziantep. Traditionally this kebab differs from other types of kebab. Simit kebab is made of simit (fine bulgur – *Triticum durum*), cumin, salt, black and red pepper, garlic along with lamp rib eye meat and it is being served with *Pistacia vera* (Birisik, 2014).

Basically, meat is a protein rich and delicious food due to some amino acids and it is also rich in fat, iron (Fe) compounds but might lack some vitamins, fiber, phenolic and antioxidant compounds. Saturated fatty acids (SFA) compose majority of fatty acid profile of meat which can increases blood cholesterol level and cause coronary heart disease (CHD) or arteriosclerosis (Milićević et al., 2014).

As a result of these concerns, there is an increasing demand for healthier and functionalized meat products and dishes. Due to the composition of its ingredients, Simit kebab is a possible candidate for a functionalized meat product. Simit, one of the basic ingredients of this kebab, is a commonly consumed cereal product in Turkey and it is being produced after cleaning, bleaching, drying and grinding processes of *Triticum durum* wheat. Simit is rich in vitamins ($B_1$, $B_2$, $B_9$ and E), fibre, starch and protein (Bayram et al., 2004). Thus, it increases the nutritional value of Simit kebab by itself.

Simit kebab is ornamented with *Pistacia vera* and served after cooking. *Pistacia vera* is a nut that is nutritionally rich in dietary fiber, protein, α-tocopherols, vitamin K, potassium, magnesium. Fatty-acid profile of pistachio nuts can meet a healthy diet of consumers via reducing SFA and increasing monounsaturated fatty acid (MUFA) or polyunsaturated fatty acid (PUFA) intake (King et al., 2008; Lloyd-Jones et al., 2010). With moderated amount of consumption, pistachio can also help controlling body weight as a result of their satiety and satiation effects (Lin & Yen, 2010).

Pistachio nut has been suggested as a source of phenolic and antioxidant compounds which have a key role against free radicals (Kornsteiner et al., 2006). Since the formation of free radicals can cause cancer, atherosclerosis or inflammatory diseases (Scalbert & Williamson, 2000), it is important to supply foods with source of these compounds rich ingredients. Those health promoting compounds can be degraded and lose their activity because of high temperature during the cooking process (Seeram et al., 2006).

Many scientist have tried to modify the ingredients used to make meat products healthier (Jiménez-Colmenero et al., 2001; Kim et al., 2000; Lee et al., 1998).Therefore, the purpose of this study was to formulate a healthy and functionalized meat product by addition of *Pistacia vera* and determine its effects on physicochemical properties of Simit kebab and to to investigate the effects of the cooking process as well as the finding of the most healthy and most delicious formula.

## Materials and Method

### Materials

Yearly sheep meat (minced rib eye muscle), simit (fine bulgur – *Triticum durum*), garlic *(Allium sativum),* cumin *(Cuminum cyminum),* black pepper *(Piper nigrum)* and red pepper powder *(Capsicum annuum)* were all purchased from local markets in Kayseri/Turkey. Ground Antep pistachio nuts *(Pistacia vera)* was purchased from Gaziantep/Turkey.

#### *Preparation of Simit Kebab*

Prior to kebab mixture preparation, simit was moisturized by soaking it in a hot water 1:1 (w/v) and sat for 15 minutes to swell and have softer texture. Afterwards, a total of 2.5 kg kebab was prepared according to 80% (w/w) minced meat, 16% (w/w) swollen simit, 1.5% (w/w) garlic, 1% (w/w) red pepper, 0.3% (w/w) black pepper, 0.2% (w/w) cumin, 1% (w/w) salt formula. All ingredients were mixed homogeneously and divided into 4 different groups to prepare experimental kebab mixtures. Dry Antep pistachio nuts were unshelled and grounded and then added into the kebab formula. The control group was prepared without pistachio nuts (group 1), while the other groups containing 5%, 7.5%, 10% pistachio nuts (pistachio/kebab mixture, w/w). The samples prepared and firstly wrapped with stretch film and then covered with aluminium foil as second layer to avoid light exposure. The four different groups had been re-produced in three different sets (n=3). The samples were stored for 3 days at 4°C. For cooked kebab analysis kebab mixtures were placed on an oven tray (kebab dimensions:15 width x 15 length, 2cm thickness) and cooked at 200°C for 20 minutes.

Proximate, color, total phenolic content, total antioxidant capacity and fatty acid composition analysis were carried out on 0th and 3rd day of storage (4°C) on raw samples in triplicate. Sensory analysis was only carried out for cooked samples for the 0th and 3rd day storage (4°C).

### Methods

#### *Proximate and Color Analysis*

Ten grams of kebab samples were measured and dried at 105°C for 4 hours in a drying oven (Nüve FN 120, Ankara, Turkey) using evaporating dishes to determine the dry matter of samples. Total fat content (%) of samples was determined by extracting fat by using Soxhlet extraction method (AOAC, 2000). Raw products were prepared for pH analysis in triplicate by blending 10 grams of samples in 90 ml of distilled water and pH measurements carried out with a calibrated pH meter (Mettler Toledo, Schwerzenbach, Switzerland). Surface color values of both raw and cooked kebab samples were measured by using white and black calibrated chromameter (Konica Minolta, model CM-5/Japan) and recorded as $L^*$ (brightness), $a^*$ (redness), $b^*$ (yellowness). The results were expressed as the average values from ten different trials. The proximate analysis were carried out in triplicate.

#### *Total Phenolic Content Analysis*

Phenolics were extracted with slight modifications according to the method by (Qwele et al., 2013). Briefly, 10g of the experimental kebab samples were homogenized with 90 mL of phosphate buffer (pH=7.0) then shaken for 1 hour at room temperature by using a shaker and eventually centrifuged at 12000g for 1 hour at 4°C (Hitachi, Tokyo, Japan). Supernatants were passed through Whatman no. 54 filter paper and used for both of total phenolic content and antioxidant capacity analysis.

Total phenolic content of the kebab samples was measured photometrically according (Gutfinger, 1981) with some modifications. One hundred µL of the supernatant

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was mixed with 200 µL of Folin-Ciocalteu reagent. Afterwards, 3 mL of $Na_2CO_3$ (5%) was added and the samples were incubated for 2h at room temperature. Absorbance of samples measurements was at 765 nm using an Agilent UV-Visible spectrophotometer (Agilent 8453, US). Total phenolic content results were given as mg gallic acid equivalent (GAE)/kg sample based on a gallic acid standard curve ranging from 0 to 1 mg/mL.

### *Total Antioxidant Activity Analysis*

This activity was determined by using the method described by Qwele et al. (2013). An aqueous, 400 µL of the supernatant was mixed with 1600 µL of distilled water, 2 mL of 0.2 mmol/L DPPH solution (prepared in methanol), respectively. Samples were incubated in a dark place at room temperature for 30 min. The absorbances of samples were measured at 517 nm by using an Agilent UV-Visible spectrophotometer (Agilent 8453, US). As blank methanol was used and DPPH inhibition percentages of samples were calculated using the following formula:

$$Inhibition(\%) = [(absorbance\ of\ control - absorbance\ of\ sample) / absorbance\ of\ control] \times 100$$

### *Fatty Acid Composition Analysis*

The free fatty acids composition was determined with Gas Chromatography (GC) system (Agilent 6890, Ar., USA) by using the method described by Capar & Yalcin (2017). For methylation of fatty acids 100 mg of fat, gathered from Soxhelet extraction of kebab samples, was dissolved in 3 ml hexane and saponified with 100 µl of 2 mol/L KOH (prepared with methanol) and vortexed for one minute (Nüve NM 110, Turkey). Solution was centrifuged at 5000 rpm for 5 min at 25°C (HettichRotina 380, Tuttlingen, Germany) for separation of solid materials and liquid phase. One ml of liquid phase was placed into vials to be automatically injected to GC equipped with a Flame Ionization Detector (FID) and HP-88 column (0.25 mm × 100 m ID). Injection block temperature was at 250°C. Onset temperature of oven was 103°C for 1 min, then raised up to 170°C with rate of 6.5°C/min, from 170°C to 215°C with rate of 2.75°C/min and from 215°C to 230°C and then kept at same temperature for 5 min. Helium gas was used as mobile phase with 2 ml/min flow rate and split rate was 1/50. Fatty acid composition profile was expressed as % in total triglyceride.

### *Sensorial Analysis*

Sensory analysis of the samples were carried out by eight semi-trained panelists (5 female – 3 male, with age average of 25) using hedonic type chart. Hedonic chart scores ranged from 1 to 9, lowest score '1' used for samples out of flavor and highest score '9' used for most desirable samples (Stone et al., 2012). The panelists were trained in 2 hours sessions per week for 5 weeks, resulting in a total 10 hours of training. They were trained to evaluate cooked simit kebab for perception of various taste, smell and color characteristics. Panelists training included group session to taste and describe the tastes/flavors of simit kebab. Surface color, taste, smell and overall acceptability of the cooked simit kebab were evaluated by the panelists during the storage.

### *Statistical Analysis*

The data were analyzed using two-way analysis of variance (ANOVA) with the statistical analysis software SAS (SAS, Institute, 2001). Tukey multiple range test was used for comparison of the means to find the effects of pistachio concentration and storage periods and their interaction for various parameters in the different experiments. A significance level of 5% was approved for all comparisons.

## Results and Discussion

### Proximate Analysis

pH, dry matter and total fat values of Simit kebab enriched with different concentration of pistachio nut and stored under refrigeration are shown in Table 1. Results of pH analysis was higher for the 10% supplemented sample (6.02±0.04) on day zero and lower for the 5% sample at 3rd day (5.32±0.04) when compared to the control group. pH showed significant differences ($p<0.05$) with regard to both pistachio nut concentration and storage period. The pH values had a reduction during the course of storage except for the control sample. The pH value of the control sample slightly increased during storage. An increase in pH may be due to protein degradation, which produces small alkaline molecular nitrogen-containing components (Lu et al., 2011). Virgili et al. (2007) reported that changes in pH during storage may be affected by compounds with low-molecular weight formed as a result of endogenous and exogenous activities in the structure of the product. According to Santos et al. (2005) the reduction in pH during storage regardless of the packaging method in Morcilla de Burgos, was explained by the activity of lactic acid bacteria. pH values of samples are in agreement with those reported by Hopkins and Fogarty (1998) for lamb meat and a positive relationship was found between fresh and stored meat pH ($r=0.57$, $P<0.005$).

The value of dry matter ranged from 48.42% to 57.40% at the 0th day and from 52.34% to 59.96% on the 3rd day of storage. Dry matter of Simit Kebab slightly decreased but also increased (ups and downs) through 3 the days of storage. Dry matter in the control and 5% supplemented samples was increased by 57.4% to 59.96%; 48.42% to 54.59% during storage, respectively. Moreover, dry matter of 10% supplemented sample did not change whereas 7.5% supplemented sample decreased during storage. According to the study of Malek et al. (2009), buffalo and beef meat dry matter was slightly decreased during 120 days of storage. In the control sample, the dry matter was found as 57.4% and data indicates that the storage had a significant effect on the dry matter ($p<0.05$), which was in agreement to a study conducted on fresh meat where it was increased from 32.4% to 58.3% (Bender, 1992).

The total fat content of Simit kebab decreased significantly during the course of storage ($p<0.05$). It was notably ($p<0.05$) affected by the added pistachio nut concentration. In control samples, fat content was found as 44.12,

**TABLE 1:** *Physicochemical properties of raw kebab samples (n=3).*

| Sample | pH | | Dry matter (%) | | Total Fat (%, dry based) | |
|---|---|---|---|---|---|---|
| | 0th Day | 3rd Day | 0th Day | 3rd Day | 0th Day | 3rd Day |
| Control | $5.83^{Bc}$±0.03 | $5.99^{Aa}$±0.15 | $57.40^{Ba}$±1.17 | $59.96^{Aa}$±1.32 | $44.12^{Aa}$±1.81 | $40.84^{Ba}$±0.84 |
| 5% | $5.98^{Aa}$±0.05 | $5.56^{Bb}$±0.19 | $48.42^{Bb}$±2.94 | $54.59^{Ab}$±2.06 | $46.86^{Aa}$±1.99 | $37.99^{Ba}$±0.78 |
| 7.5% | $5.95^{Ab}$±0.06 | $5.32^{Bc}$±0.04 | $56.09^{Aa}$±1.28 | $53.68^{Bb}$±1.27 | $40.99^{Ab}$±1.11 | $39.42^{Bb}$±3.63 |
| 10% | $6.02^{Aa}$±0.04 | $5.50^{Bbc}$±0.04 | $52.34^{Ab}$±1.30 | $52.34^{Ab}$±1.07 | $46.83^{Aa}$±1.77 | $38.08^{Ba}$±1.12 |

* Values of analogue properties within the sample-type in the column having different small superscript letters were significantly different at $p<0.05$. * Values of analogue properties within the time-points in the row having different capital superscript letters were significantly different at $p<0.05$.

which is similar to results reported by Bender (1992) for fresh meat as 41.6%. Although 5% and 10% enriched samples had an increase, 7.5% enriched sample had a decrease in fat level on the 0th day of storage (Table 1). During storage fat content decreased in all samples, which may refer to lipid oxidation during storage because of the large surface area of minced meat (Ismail et al., 2009). Mitsumoto et al. (2005) studied lipid stability during chilled storage in cooked and raw beef and chicken patties. They concluded that chicken meat was more stable to lipid oxidation than beef. The main reason might be to have very low fat content (0.3%) compared to beef (5.6%).

## Color

The color evaluation was performed to detect the effect of pistachio nut addition and storage in Simit Kebab. Color of meat is perceived to be a valuable parameter on the overall quality of meat and it also influences the perceptions of consumers (Montgomery et al., 2003; Ngapo et al., 2004), because red color is associated with freshness (Wood et al., 2004). Predictably, the addition of pistachio nut caused a decrease in redness, thus causing Simit Kebab to became slightly greener ($p<0.05$). The lightness of the samples decreased with the increasing pistachio ratio ($p<0.05$). However, yellowness of the samples had a fluctuation. Such a change in redness has also been reported by Serrano et al. (2006).

During the storage, *L** values of the samples increased ($p<0.05$). Studies related to meat color and storage are all in agreement with increasing duration of refrigerated storage increases *L** values (Luciano, Monahan, Vasta, Biondi, et al., 2009; Luciano, Monahan, Vasta, Pennisi, et al., 2009; Nieto et al., 2010). It has been reported that the increase in *L** value may be related to metmyoglobin formation during storage (Nieto et al., 2010). Storage affected redness *(a*)* values significantly ($p<0.05$) which increased over the storage except for the 10% sample. In contrast to our results, other studies showed that storage had negatively affected *a** value of meat (Luciano, Monahan, Vasta, Biondi, et al., 2009; Luciano, Monahan, Vasta, Pennisi, et al., 2009; Nieto et al., 2010). Several authors reported that pigment oxidation reduces *a** value (Higgins et al., 1998; Lee et al., 1998). Yellowness *(b*)* values of samples increased with 3 days of storage ($p<0.05$), which are in harmony to earlier results published by Luciano, Monahan, Vasta, Biondi, et al. (2009).

## Total Phenolic Content

*Pistacia vera* is a delicious nut, composed of different food matrices and an important source of various bioactive compounds such as phenolics, antioxidants, tocopherols, phytosterols (Kris-Etherton et al., 1999). The control samples, both raw and cooked, had the lowest total phenolic content for both time points (Table 3). As a matter of fact, addition of *Pistacia vera* to Simit kebab significantly increased phenolic amount of samples ($p<0.05$). Ten percent enriched sample had the highest phenolic content (2002.10±97.87 GAE/kg sample). Decisively, even after a cooking process at 200°C for 20 minutes, all supplemented samples (5%, 7.5% and 10%) retained their phenolic content at higher levels with comparison to control sample. Storing Simit kebab mixture as raw at 4°C for 3 days caused a slight decrease in phenolic content. Differences between cooked samples were regarded as significant ($p<0.05$) for both time points of all samples. Surprisingly, kebab samples rested for 3 days after the cooking process showed an increase in their phenolic content comparing to raw samples. The increase stated may be attributed to releasement of phenolic compounds to meat matrix with time. Also, the high phenolic content of samples can be attributed to the high level of phenolic compounds that comes from pistachio nuts. Thus, experimental samples of kebab were found to have higher phenolic content than the untreated meat.

**TABLE 2:** *Color properties of the raw kebab samples (n=3).*

| | | 0th Day M ± SD | 3rd Day M ± SD |
|---|---|---|---|
| L* | Control | $48.11^{Aa}$±0.08 | $48.18^{Aa}$±0.30 |
| | 5% | $47.03^{Bb}$±0.07 | $47.68^{Ab}$±0.16 |
| | 7.5% | $44.86^{Bc}$±0.07 | $46.93^{Ac}$±0.33 |
| | 10% | $44.48^{Bd}$±0.05 | $46.75^{Ac}$±0.13 |
| a* | Control | $13.93^{Ba}$±0.05 | $17.08^{Aa}$±0.37 |
| | 5% | $10.40^{Bc}$±0.08 | $10.55^{Ac}$±0.09 |
| | 7.5% | $10.71^{Bb}$±0.10 | $12.21^{Ab}$±0.15 |
| | 10% | $8.93^{Ad}$±0.04 | $8.33^{Bd}$±0.17 |
| b* | Control | $24.51^{Bd}$±0.14 | $27.64^{Ac}$±0.23 |
| | 5% | $26.60^{Bb}$±0.13 | $28.42^{Aa}$±0.21 |
| | 7.5% | $25.99^{Bc}$±0.05 | $27.74^{Abc}$±0.17 |
| | 10% | $27.83^{Aa}$±0.10 | $27.96^{Ab}$±0.12 |

M ± SD: mean ± standard deviation. *Values in the column with different small superscript letters were significantly different at $p<0.05$. *Values in the row with different capital superscript letters were significantly different at $p<0.05$.

## Total Antioxidant Activity

Similar to phenolic content results, the control sample had the lowest antioxidant activity compared to all supplemented samples (Table 3). Statistically, storing negatively influenced inhibition of DPPH for all samples ($p<0.05$). On zero-day, 5%, 7.5% and 10% enriched samples had quite similar inhibition results to each other. Additionally after being stored for 3 days, 5% enriched samples had a significant decrease in DPPH inhibition ($p<0.05$). Even after the cooking process, all samples retained their antioxidant capacity at a constant level for both time points. Even though there is a decrease in DPPH inhibition of raw samples with time, surprisingly, after cooking, samples showed a significant increase on 3rd day. Thus, this can be attributed to belief of the Maillard reaction products (MRPs), which form after interaction of amino acids and sugar at high temperatures, act like non-nutrient antioxidants (Turkmen et al., 2006). As a result of MRPs existence even after cooking at 200°C Simit kebab samples showed an increase of inhibition and covered loss of natural pistachio antioxidants (Manzocco et al., 2000; Nicoli et al., 1997).

**TABLE 3:** *Bioactive properties of the kebab samples (n=3).*

| | Total phenolic content (mg GAE/kg sample) | | DPPH (% inhibition) | |
|---|---|---|---|---|
| | 0th Day | 3rd Day | 0th Day | 3rd Day |
| **Raw Samples** | | | | |
| Control | $1309.92^{Ab}$±36.24 | $1212.42^{Bc}$±42.47 | $49.54^{Ab}$±1.06 | $30.29^{Bc}$±0.91 |
| 5% | $1882.4^{Aa}$±37.28 | $1649.60^{Ab}$±49.92 | $60.64^{Aa}$±1.76 | $39.17^{Bb}$±3.03 |
| 7.5% | $1835.96^{Aa}$±51.64 | $1703.32^{Bb}$±62.61 | $61.63^{Aa}$±1.88 | $43.12^{Ba}$±1.68 |
| 10% | $2002.10^{Aa}$±97.87 | $1935.14^{Aa}$±65.00 | $66.19^{Aa}$±1.89 | $45.86^{Ba}$±2.92 |
| **Cooked Samples** | | | | |
| Control | $805.75^{Bc}$±26.52 | $956.58^{Ac}$±60.69 | $42.97^{Bc}$±1.11 | $47.46^{Ac}$±0.53 |
| 5% | $1679.92^{Ab}$±50.09 | $1648.67^{Ab}$±136.71 | $55.29^{Bb}$±4.54 | $66.63^{Ab}$±2.10 |
| 7.5% | $1904.64^{Ba}$±89.76 | $2273.67^{Aa}$±168.81 | $62.55^{Ba}$±0.70 | $70.27^{Aa}$±1.29 |
| 10% | $1894.86^{Ba}$±67.45 | $2258.83^{Aa}$±74.95 | $60.43^{Ba}$±4.70 | $69.03^{Aa}$±0.35 |

* Values of analogue properties within the sample-type in the column having different small superscript letters were significantly different at $p<0.05$. * Values of analogue properties within the time-points in the row having different capital superscript letters were significantly different at $p<0.05$.

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### Fatty Acid Composition

Average fatty acid profiles of raw kebab samples on zero-day and 3rd day were given in Table 4. The main fatty acids in the control group were oleic acid ($C_{18:1}$) (34.52%), palmitic acid ($C_{16:0}$) (31.41%) and stearic acid ($C_{18:0}$)(15.52%). These fatty acids were similar to those reported by J. Santos-Filho et al. (2005) in goat muscle. In addition, the main fatty acid profiles in pistachio nuts were oleic acid (22.7%), linoleic acid ($C_{18:2}$) (13.2%) and palmitic acid (4.9) (Alasalvar & Shahidi, 2009) whereas in meat, they were oleic acid (31%), palmitic (19.4%) and stearic acid (17.4%) (Enser et al., 1998). According to our results, the addition of pistachio nuts increased oleic acid and palmitic acid concentration.

**TABLE 4:** *Fatty acid composition of the raw kebab samples ($0^{th}$ and $3^{rd}$ day storage) (n=3).*

| | $0^{th}$ day | | | | $3^{rd}$ day | | | |
|---|---|---|---|---|---|---|---|---|
| **Fatty acids** | **Control** | **5%** | **7.50%** | **10%** | **Control** | **5%** | **7.50%** | **10%** |
| **C 14:0** | 7.00 | 6.39 | 4.89 | 7.55 | 5.64 | 5.76 | 5.52 | 5.21 |
| **C 16:0** | 31.41 | 30.78 | 24.52 | 36.53 | 25.63 | 26.21 | 26.31 | 24.84 |
| **C 18:0** | 15.52 | 15.49 | 13.32 | 18.39 | 13.61 | 12.69 | 13.42 | 12.01 |
| **C 20:0** | ND | 0.14 | 0.14 | 0.19 | ND | ND | ND | 0.15 |
| **Total Saturated** | 53.93 | 52.8 | 42.87 | 62.66 | 44.88 | 44.66 | 45.25 | 42.21 |
| **C 16:1** | 3.10 | 3.08 | 2.26 | 3.60 | 2.60 | 2.81 | 2.60 | 2.45 |
| **C 18:1** | 34.52 | 34.28 | 45.91 | 20.43 | 43.1 | 45.34 | 44.29 | 47.36 |
| **C 20:1** | 1.21 | 1.11 | 0.86 | 1.32 | 0.89 | 0.65 | 0.77 | 0.62 |
| **Total Monounsaturated** | 38.83 | 38.47 | 49.03 | 25.35 | 46.59 | 48.8 | 47.66 | 50.43 |
| **C 18:2 (ω-6)** | 5.14 | 6.02 | 5.07 | 8.21 | 4.73 | 3.96 | 4.10 | 4.77 |
| **C 18:3 (ω-3)** | 1.24 | 1.28 | 1.01 | 1.51 | 0.88 | 0.76 | 0.77 | 0.78 |
| **C 20:5 (ω-3) (EPA)** | 0.42 | 0.88 | 0.99 | 1.51 | 1.97 | 1.21 | 1.47 | 1.18 |
| **C 22:6 (ω-3) (DHA)** | 0.44 | 0.56 | 0.50 | 0.76 | 0.93 | 0.63 | 0.74 | 0.62 |
| **Total Polyunsaturated** | 7.24 | 8.74 | 7.57 | 11.99 | 8.51 | 6.56 | 7.08 | 7.35 |
| **Total (ω-3)** | 2.10 | 2.72 | 2.50 | 3.78 | 3.78 | 2.6 | 2.98 | 2.58 |
| **Total (ω-6)** | 5.14 | 6.02 | 5.07 | 8.21 | 4.73 | 3.96 | 4.10 | 4.77 |
| **Ratio (ω-6)/(ω-3)** | 2.45 | 2.21 | 2.03 | 2.17 | 1.25 | 1.52 | 1.38 | 1.85 |

* ND.not detected. The concentrations of fatty acids lower than 0.1 written as ND.

The addition of pistachio nuts caused an increase in total PUFA concentration whereas storage caused a decrease. Most of the fatty acid concentrations had a decline due to storage except oleic acid and eicosapentaenoic acid (EPA, $C_{20:5}$). The highest PUFA concentration was found on the zero-day as 11.99%, whereas the highest MUFA concentration was on 3rd day of storage and 10% pistachio enriched samples, like 50.43%. Storage process did not alter ω-3 PUFA concentrations more than saturated fatty acid or MUFA concentrations, but storage seemed to have an adverse effect on ω-6 PUFA concentrations. During storage, all saturated fatty acids decreased with the exception of 7.5% supplemented samples. Likewise, all unsaturated fatty acids decreased with the exception of $C_{18:1}$ oleic acid, which had increased. Due to the oxidation reactions during storage, it was expected that the amount of unsaturated fatty acid level could be decreased. However, a reduction in $C_{18:0}$ percentage and an increase in $C_{18:1}$ percentage were unexpected. J. M. Santos-Filho et al. (2005) explained that $C_{18:1}$ was synthesized from $C_{18:0}$ with the activity of Δ9-desaturase enzyme in goat tissues during storage. Therefore, $C_{18:0}$ percentage could decrease and C18:1 percentage could increase. Health benefits of consumption ω-3 fatty acids especially; eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) have been reported by various studies (Dal Bosco et al., 2004; Mozaffarian & Wu, 2011; Simopoulos, 1991). Especially Western-type diets include high intake of ω-6 in contrary to ω-3. Recent studies for human diets suggested increasing ω-3 consumption and decreasing the ω-6/ω-3 ratio to 5:1 or 10:1 as recommended by World Health Organization (Dal Bosco et al., 2004; Simopoulos, 1991). According to our results, ω-6/ω-3 ratio were found between 2.45 and 1.25, which remains within the recommended ratio.

### Sensorial Evaluation

The sensory scores of the cooked simit kebab samples with the different pistachio nut concentrations are illustrated in Table 5. The sensory quality scores evaluated color, taste, smell and overall acceptability decreased during storage. Generally, storage had a significant ($p<0.05$) effect on all of the sensory attributes. At the first day of the storage, pistachio enriched samples had higher scores compared to control samples. Additionally, 5 and 7.5% enriched samples both had highest scores from panelists. On the 3rd day, similar to zero-day, samples had significantly higher scores than that expressed by the control sample, while 7.5 % enriched samples had a significant decrease in taste score and 10% enriched sample had a decline in color score ($p<0.05$).

Even though the 5% enriched sample showed a decrease of its' overall acceptability score, it had higher scores for all parameters compared with other samples at 3rd day. According to this result, it can be suggested that from sensorial properties point of view the 5% sample is the most appropriate formulation even after storing for 3 days.

## Conclusion

Meat and meat products are essential components of the human diet. Meat products have to be processed such as cooking, which is a desirable process to improve meat flavors. Cooking and processing may lead to protein oxidation, which may decompose their components into aldehydes, esters, alcohols. All may result in undesirable flavors and have mutagenic and carcinogenic effects. To provide healthier meat and meat products, it is necessary to increase the level of functional ingredients that induce potential properties. Nuts have been described as a great source of health providing compounds like antioxidants, phenolics, PUFA and MUFA when consumed in moderate amounts. Pistacia vera supplementation to traditional

**TABLE 5:** *Sensory properties of cooked kebab samples (n=3).*

| Sample | Color | Taste | Smell | Overall Acceptability |
|---|---|---|---|---|
| **$0^{th}$ Day** | | | | |
| **Control** | $6.0^{Ab}$±1.63 | $6.5^{Ab}$±1.62 | $6.5^{Aa}$±1.62 | $6.5^{Ab}$±1.51 |
| **5%** | $8.0^{Aa}$±0.81 | $8.0^{Aa}$±0.69 | $7.5^{Aa}$±0.53 | $8.0^{Aa}$±0.69 |
| **7.5%** | $8.0^{Aa}$±0.69 | $8.0^{Aa}$±1.15 | $7.5^{Aa}$±0.98 | $8.0^{Aa}$±0.76 |
| **10%** | $7.5^{Aa}$±1.38 | $8.0^{Aa}$±0.48 | $7.0^{Aa}$±0.95 | $7.0^{Ab}$±1.21 |
| **$3^{rd}$ Day** | | | | |
| **Control** | $6.5^{Aab}$±0.98 | $6.0^{Aa}$±1.68 | $5.5^{Aa}$±1.39 | $6.0^{Aa}$±0.69 |
| **5%** | $7.5^{Aa}$±1.11 | $7.0^{Aa}$±1.07 | $6.5^{Aa}$±1.39 | $6.5^{Ba}$±1.11 |
| **7.5%** | $6.5^{Aa}$±1.27 | $5.5^{Aa}$±1.49 | $6.0^{Aa}$±1.35 | $6.0^{Ba}$±1.38 |
| **10%** | $5.5^{Aa}$±1.72 | $6.5^{Ba}$±1.13 | $6.0^{Aa}$±1.35 | $6.0^{Ba}$±1.35 |

* Values in the column with different small superscript letters were significantly different at $p<0.05$.
* Values in the row with different capital superscript letters were significantly different at $p<0.05$.

Simit Kebab significantly influenced total phenolic content, total antioxidant activity, and improved color and fatty acid profile ($p<0.05$). Furthermore, the total phenolic compounds and antioxidant activities in the treated samples were stable in cooked samples, which indicates that the antioxidant compounds in Pistacia vera are heat-resistant bioactive compounds.

In view of the observed benefits, Pistacia vera may be used as a healthy ingredient in traditional foods to improve its benefits so that consumers should not hesitate to consume such products. Other nuts such as walnuts and hazelnuts can be investigated in the future in formulas of traditional meat-based products as a new approach to producing healthier and tastier foods.

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## Conflict of interest

We have no conflict of interest to declare.

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