Effect of Cold Storage on Color Properties and Antioxidant Capacity of Sous Vide Cooked Green Bean

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Abstract

Sous vide technique, a novel cooking technique, can preserve vegetables' quality more than traditional cooking techniques. However, there are limited studies on the changes in quality properties of the Sous vide cooked vegetables during cold storage. This study aimed to investigate the effects of cold storage on the color properties and antioxidant capacities of the Sous vide cooked green bean. The Sous vide cooked samples were stored in the refrigerator. The color properties, total phenolics content (TPC), and antioxidant activity (2,2-diphenyl-1-picrylhydrazylradical (DPPH) radical scavenging activity and ferric reducing antioxidant power (FRAP)) were determined at 0^{th}, 1^{st}, 3^{rd}, 5^{th}, and 10^{th} day of storage. The findings of this study revealed that the cold storage had a significant positive impact on the lightness (L*) value ($P<0.05$). However, it did not have a significant impact on the redness-greenness (a*) and yellowness-blueness (b)* values ($P>0.05$). After 10 days of storage, the TPC content of the green bean samples decreased from 534±34 mg 100 g^{-1} to 476±78 mg 100 g^{-1} ($P>0.05$). Moreover, the DPPH radical scavenging activity and FRAP decreased significantly from 2864±131 µmol 100 g^{-1} to 2209±247 µmol 100 g^{-1} and from 1278±103 µmol 100 g^{-1} to 1055±119 µmol 100 g^{-1}, respectively ($P<0.05$).

Keywords: Antioxidants, Cold storage, Cooking, Sous vide

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INTRODUCTION

The gastronomy and industry present new techniques in the preparation of foods to satisfy consumers' different needs. Sous vide is one of these new techniques (Roascio-Albistur and Gambar, 2018). In this technique, foods in vacuumed plastic pouches are cooked under the controlled conditions of temperature and time. Although Sous vide technique has been used by chefs since the 1970s, it has become well-known since the mid-2000s. This cooking technique has two main differences from the traditional cooking techniques: 1) foods are inserted in heat-stable vacuumed plastic pouches and then cooked 2) cooking temperature is precisely controlled (Baldwin, 2012).The application of Sous vide cooking technique comprises various foods such as meat and meat analogs (Gomez et al., 2019), pork ham (Jeong et al., 2018), lamb loins (Roldan et al., 2013), mackerel fillet (Cropotova et al., 2019), asparagus spears (Gonnella et al., 2018), Brassica vegetables (Florkiewicz et al., 2019), carrot and Brussel sprouts (Rinaldi et al., 2013).

Sous vide technique can preserve the nutritional values and sensorial properties of vegetables more than traditional cooking techniques. There is no contact between food and water. In this way, it prevents the loss of nutrients into cooking water (Armesto et al., 2017). After the application of Sous vide, foods can be rapidly chilled and stored in refrigerator for long term (10 days). Cold storage can have impact on the quality of vegetables, especially on color and antioxidant properties.

Epidemiological studies have revealed that the consumption of vegetables may be inversely correlated with chronic diseases. Green bean (*Phaseolus vulgaris L*. Fabaceae), an economically important vegetable, is used as fresh, canned and frozen. It is a good source of vitamin, mineral, and phenolic compounds. Its anti-glycaemic, hypo-lipidaemic, and antioxidant properties were reported (Abu-Reidah et al., 2013; Aquino-Bolanos et al., 2021).

In our knowledge, there are a lot of studies on the effect of the Sous vide cooking on the antioxidant capacities of vegetables (Armesto et al. 2019; Florkiewicz et al., 2018; Gonella et al., 2018, Kosewski et al., 2018; Lafarga et al., 2018). However, available studies on the effect of the cold storage on the antioxidant capacities of the Sous vide cooked vegetables are limited (Armesto et al., 2017). The aim of this study was to investigate the changes in the color properties and antioxidant capacity of the Sous vide cooked green bean during 10 days of storage in the refrigerator. The color properties, TPC, DPPH radical scavenging activity, and FRAP of the green samples were analyzed 0^{th}, 1^{st}, 3^{rd}, 5^{th} and 10^{th} days of storage.

MATERIAL and METHOD

Chemicals

Analytical grade chemicals and solvents were provided from Sigma-Aldrich Co. (Germany).

Material

The green beans were provided from a local market in Trabzon Province (Turkey). They were stored at 4°C overnight before the preparation for cooking.

Preparation of Green Beans

The green beans were washed and then dried with a towel. The dried beans were cut with a knife at 4-5 cm thick. A 100 g of the sliced beans were weighed and then placed in a vacuum bag. Food vacuum machine (Küchenpratic HP-6001, China) was used to close the bags.

Sous Vide Cooking

The vacuum bags were put in a water bath (GFL 1008, Germany). The samples were cooked at 90°C for 60 min. After the cooking, the samples were cooled.

Storage

The cooked samples were stored at 4° C for 10 days. Triplicate samples were prepared for each day. The samples were analyzed at 0^{th}, 1^{st}, 3^{rd}, 5^{th}, and 10^{th} day.

Color Properties

L*, a*, and b* values of the green bean samples were measured with a chromometer (Konica Minolta CR-400, Japan)

Preparation of Extracts

After the homogenization of the green bean samples, 0.5 g of the sample was weighed, and 5 ml of the methanol (80%) was added. The extraction was performed in an ultrasonic bath (Bandelin RK 103 H, Germany) for 30 min. The samples were centrifuged at 4000 rpm for 5 min (Centurion Scientific K2015R, United Kingdom). The extraction procedure was repeated. The combined supernatants were stored at -18 °C until the analysis

Total Phenolic Content

After 0.1 ml of the extract, 0.5 ml Folin Chiocalteu reagent, 0.4 ml sodium carbonate (1 M), and 4 ml water were mixed, then the solution was kept at dark for 1 hour. The absorbance of the solution was measured at 760 nm. The calibration curve was prepared with gallic acid. The TPC was expressed as mg gallic acid equivalent 100 g^{-1} dry matter.

DPPH Radical Scavenging Activity

0.1 ml extract and 1.9 ml DPPH reagent (60 µM) were mixed, and the solution was stored at dark for 1 hour. The absorbance was measured at 515 nm. The calibration curve was prepared with Trolox. The DPPH radical scavenging activity was expressed as µmol Trolox equivalent 100 g^{-1} dry matter.

FRAP Antioxidant Power

0.1 ml extract and 1.9 ml FRAP reagent were mixed, and the solution was stored at dark for 20 min. The absorbance was measured at 595 nm. The calibration curve was prepared with Trolox. The FRAP antioxidant power expressed as µmol Trolox equivalent 100 g^{-1} dry matter.

Statistical Analysis

Triplicate samples were analyzed at 0^{th}, 1^{st}, 3^{rd}, 5^{th}, and 10^{th} days of storage and at least duplicate analysis was carried out for each sample. Mean values and standard deviations were calculated. One-way variance analysis and Duncan test were applied to evaluate the differences among the samples (P< 0.05).

RESULTS and DISCUSSION

Table 1 presents the color properties of the green bean samples during the storage. The lightness (L*) value of the green bean samples increased significantly from 43.79 to 48.84 after 10 days of storage (P<0.05). Moreover, the yellowness-blueness (b*) value of the green bean samples increased from 19.95 to 23.51. However, no significant difference was found among the samples (P> 0.05). The redness-greenness (a*) value showed no significant difference during 10 days of storage as the b* value (P> 0.05).

Table 1. Color properties of the green bean samples during cold storage.

Properties	Day				
	0	1	3	5	10
L* value	43.79±1.12 [b]	45.81±1.56[ab]	44.43±3.79 [ab]	44.87±3.10 [ab]	48.84±2.19 [a]
a* value	-3.27±0.99 [a]	-4.32±0.28[a]	-3.41±0.94 [a]	-3.35±0.34 [a]	-3.59±0.72 [a]
b* value	19.95±2.66 [a]	21.63±0.37[a]	20.64±2.36 [a]	21.22±1.33 [a]	23.51±2.69 [a]

Different letters in raw present significant difference (P< 0.05)

The color of green vegetables is mainly associated with chlorophyll (Rinaldi et al., 2013). The degradation of chlorophyll into its isomers leads to color changes.

A reduction in the greenness can be observed due to the degradation of chlorophyll during storage (Iborra-Bernard et al., 2013). No significant change in the greenness (a*) of the green bean samples was observed during 10 days of storage in the refrigerator. It could be concluded that the loss of chlorophyll was negligible during 10 days of storage.

Figure 1 presents the TPC of the green bean samples during the storage. The TPC values of the samples varied from 470±48 to 540±72 mg 100 g^{-1} (dry matter). The TPC of the green bean samples decreased from 534±34 to 476±78 mg 100 g^{-1} (dry matter). However, no significant difference was found among the samples with respect to the storage day (P> 0.05).

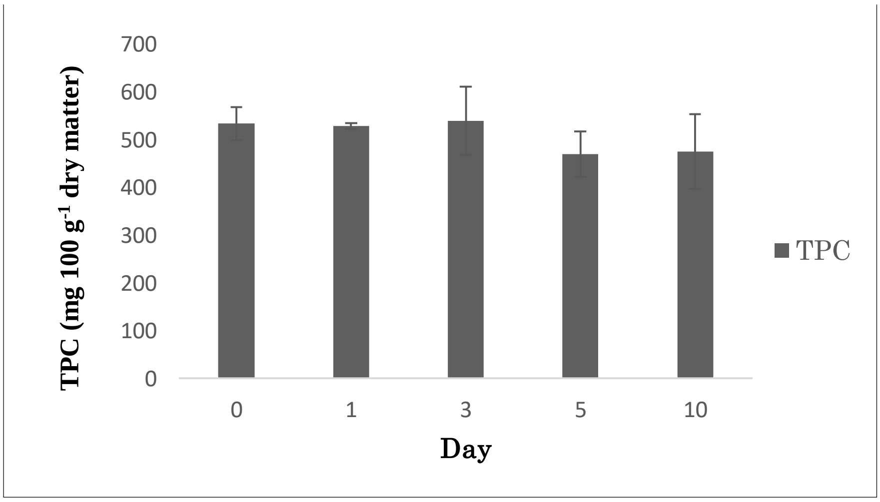

Figure 1. TPC of green bean samples

A reduction in the TPC could be related to the oxidation of phenolic compounds due to the disruption of cell wall during cooking and to the rearrangement of vegetable matrix during storage. Similar findings were reported for Brussels sprouts (Chiavaro et al., 2012) and kale (Armesto et al., 2017).

Figure 2 presents the DPPH radical scavenging activity of the green bean samples during the storage. The DPPH radical scavenging activity of the samples significantly decreased from 2864±131 to 2209±247 µmol 100 g^{-1} (dry matter) after 10 days of storage (P<0.05). However, no significant difference was found among 1^{st}, 3^{rd}, 5^{th}, and 10^{th} day of storage.

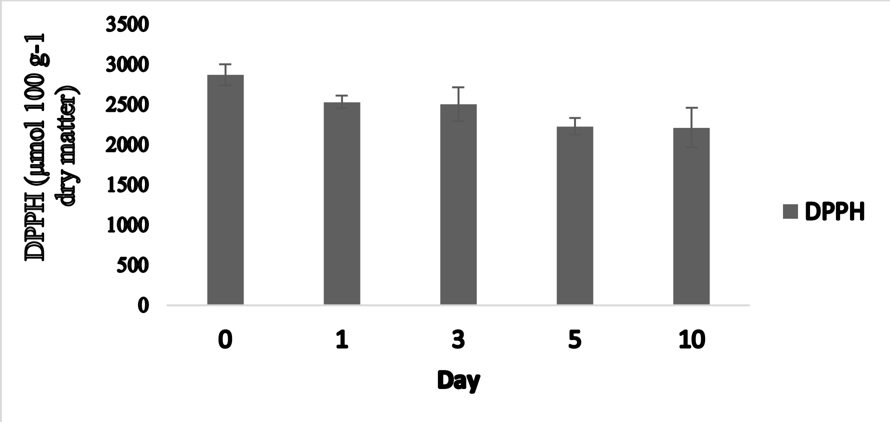

Figure 2. DPPH radical scavenging activity of green bean samples

Figure 3 presents the FRAP values of the green bean samples during the storage. The FRAP values of the samples varied from 941±70 to 1278±103 µmol 100 g^{-1} (dry matter). The FRAP values of the green been significantly decreased from 1278±103 to 1056±119 µmol 100 g^{-1} (dry matter) after 10 days of storage ($P<0.05$). However, no significant difference was found among 1st, 3rd, 5th, and 10th day of storage ($P> 0.05$).

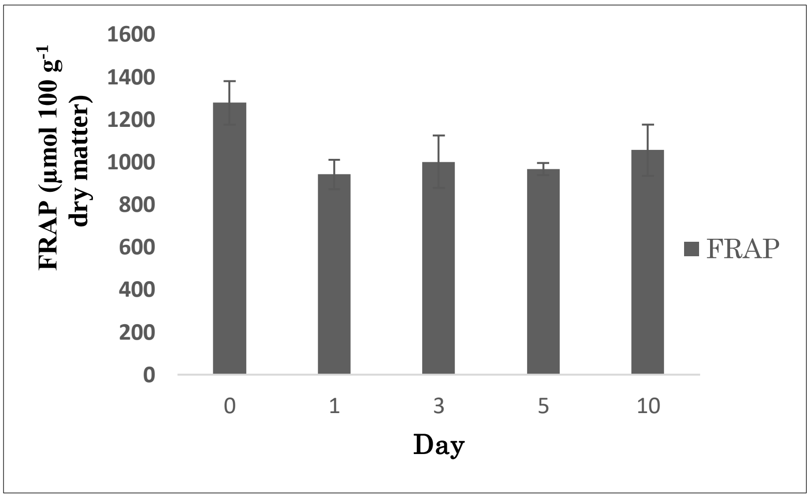

Figure 3. FRAP values of green bean samples

Green bean includes antioxidant compounds such as ascorbic acid, carotenoids, and phenolic compounds. Phenolic acids, flavonoids, and lignans as phenolic compounds were detected in green bean varieties (Abu- Reidah et al., 2012). After a significant reduction at 1st day of storage, the antioxidant capacity was retained until the end of storage. A reduction in the antioxidant capacities of the green bean could be related to the oxidation of antioxidant compounds (Armesto et al., 2017). Some studies supported our findings.

Chiavaro et al. (2012) reported a reduction in the FRAP of Brussels sprouts after 10 days of cold storage. Moreover, Armesto et al. (2017) determined a reduction in the DPPH radical scavenging activity of the kale samples after 7 days of cold storage.

CONCLUSION

The changes in the color properties, TPC, and antioxidant capacities of the Sous vide cooked green bean samples were determined during 10 days of storage in the refrigerator. The lightness of the green been increased during the cold storage. The TPC of the green bean seemed to be retained during the cold storage. However, the antioxidant capacity decreased at the first day and then retained. Further studies should focus on the changes in the antioxidant compounds of vegetables during the cold storage.

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