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Physico-chemical parameters and acceptability and of spleen-treated beef patties

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Abstract. Iron deficiency is one of the world's most common disorders and it occurs when the amount of iron available is insufficient to meet an individual's needs. Spleen is known as a food product rich in iron content, and is a cheap offal. Therefore, consumption of spleen, both directly and indirectly, and especially for the treatment of anemia (iron deficiency) disorder is advised by the medical profession. However, consumption of cooked spleen is unacceptable to many people, due to its bloody structure. In this study, the effect of adding spleen at 0, 5, 10 or 15% to beef patties was studied and physico-chemical (pH, color and iron content) and sensory changes (color, odor, chewiness, flavor and overall acceptability) in the patties were investigated. Along with incremental increases of spleen content in beef patties, pH and iron content were increased, lightness L* and redness a* values were decreased, but yellowness b* values were not significantly different between the patties with added spleen ($P>0.05$). In terms of sensory analysis, panelists generally appreciated the patties with 10% spleen more than the other spleen levels.

1. Introduction

Although iron is an abundant element in the world, iron deficiency (anemia) is one of the most common human disorders worldwide. Iron deficiency occurs when the amount of iron available is insufficient to meet an individual's needs. Estimates indicate that over 2 billion people suffer from iron deficiency, and more than half of them are anemic. The prevalence of anemia is especially common among pregnant, infants, and children under the age of 2 years [1, 2]. Consequently, various treatments exist for iron deficiency, such as drug supplementation with iron, consumption of foods rich in iron (liver, spleen, fish, egg etc.) and products enriched with iron. For example, 100 g of raw beef spleen contains approximately 19 mg iron, and this amount increased up to 47.15 mg per 100 g after cooking [3]. Compared to other products (egg, fish etc.), although spleen is fairly rich in iron, it has some negative sensory properties such as texture, odor and flavor. Therefore, it is not an offal type that is frequently preferred by consumers. The aim of this study was to determine the effect of adding spleen to beef patty formulations on some physico-chemical (pH, color, iron content) and sensory properties of beef patties.

2. Materials and Methods

2.1. Preparation of beef patties
Fresh beef brisket and rib meat was obtained from a local meat processor in Denizli. Approximately, 2 kg of fresh meat was minced using a meat mincer (PM-70, Mainca, İspanya) through a plate with 3 mm holes. The minced beef mixture was divided into four to prepare the following formulations: Control (without spleen) and 5, 10 and 15% added spleen. For patty preparation, minced meat was mixed with salt (1%) and spleen, and then kneaded by hand for 15 minutes. Patties (25 ± 1 g) were molded using a metal shaper (6 cm diameter and 1 cm thickness) and polystyrene foam plate and stored at 2°C until analysis.

2.2. Analysis
The color values (L* (lightness), a* (redness), b* (yellowness) of patties was assessed with a colorimeter (Hunterlab Miniscan XE Plus, USA). To measure pH, 10 g of patty was homogenized with 90 ml of distilled water and homogenate pH was measured with a digital pH meter (Crison Basic 20, Spain). Before pH measurements, the pH meter was standardized using pH 4, 7 and 10 buffer solutions (Merck, Germany).

A Perkin-Elmer Analyst 700 atomic absorption spectrometer (AAS) (Norwalk, CT, USA) was used for analyses of the iron (Fe) in this work. The measurements were conducted in an air/acetylene flame. The running parameters for iron element were operated as suggested by the manufacturer. All measurements were performed in triplicate. Patty (1.0 g) was weighed on an analytical balance, and then 10 mL HNO_3 was added. This mixture was predigested by standing in open vessels for a minimum of 15 mins before sealing the vessels. Digestion was conducted using a microwave system, power set at 1030 and 1800 watts, ramp time 20-25 min, hold 15 mins. Preliminary experiments showed that 15 min hold digestion time was suitable for digests without insoluble materials and at 200°C.

The patties were evaluated by a 20-member semi-trained panelist team selected from Pamukkale University Department of Food Engineering students. The patties were cooked in a conventional oven (Termikel 13007, Turkey) at 130°C for 20 min until the internal temperature reached 80°C and then, all cooked patties were coded with 3-digit random codes and offered to the panelists in a random order. Sensorial properties color, odor, chewiness, flavor and overall acceptability were evaluated using a seven point hedonic scale, ranging from dislike extremely unacceptable (score: 1) to like extremely acceptable (score: 7).

The statistical design of the study was 4 (treatments) * 3 (replications) randomized block design and all parameters were measured in duplicate (n = 24). A one-way analysis of variance (ANOVA) and Duncan's Multiple Range Test were performed to analyze in order to evaluate effects on the treatments and the storage periods using SPSS for Windows (SPSS version 15,0 for Windows). Critical difference was determined at the 5% significance level.

3. Results and Discussion
Color plays an important role in both the quality and consumers' acceptance of meat and meat products. Physico-chemical properties (color, pH and iron content) of beef patties are presented in Table 1. Patties containing spleen had lower L* (lightness) values than control patties (P<0.05). A statistical difference in a* (redness) values among the patties was observed, shown in Table 1. As expected, L* (lightness) and a* (redness) values decreased with the increasing amounts of spleen due to the fact that spleen has a substantially red pigment. The patties containing 15% spleen had lowest L* and a* values among the patties (P<0.05). The addition of spleen did not significantly alter the b* (yellowness) values (P>0.05), but the b* values of the patties fluctuated.

The pH of the patties increased from 6.50 to 6.90 as the proportion of spleen increased from 0 to 15% in the beef formulation. Patties with spleen had slightly higher pH than the control patties (P<0.05).

Iron contents of the patties were between 11.8-28.5 µg/g. The iron content of patties with 15% spleen was approximately 2.5-fold higher than that of control patties. Moreover, as the proportion of spleen increased in the beef patty formulations, iron content increased and differences were statistically significant (P<0.05).

Table 1. Physico-chemical properties (color, pH and iron content) of beef patties

	L* (lightness)	a* (redness)	b* (yellowness)	pH	İron Content (µg/g)
C	41.31±0.23[a]	11.90±0.41[a]	21.59±0.29[b]	6.50±0.02[b]	11.8±0.4[d]
5%	36.99±0.31[b]	7.05±0.40[b]	23.96±0.21[a]	6.87±0.01[a]	15.5±0.7[c]
10%	34.84±0.19[c]	6.12±0.35[bc]	22.99±0.27[a]	6.88±0.01[a]	23.2±1.2[b]
15%	32.45±0.32[d]	6.01±0.33[c]	23.01±0.31[a]	6.90±0.02[a]	28.5±1.3[a]

[a, b, c, d] Values with different superscripts within the same column are significantly different (P<0.05); C: control beef patties without spleen; 5%: beef patties with 5% spleen, 10%: beef patties with 10% spleen; 15%: beef patties with 15% spleen

Results of sensory analysis (color, odor, chewiness, flavor and overall acceptability) of beef patties are given in Table 2. Patties with 15% spleen were a different color to control patties (P<0.05), while color differences between control and patties with 5% spleen were not significant (P>0.05). Although patties with 5% spleen had the highest sensory odor scores (6.00), there was no odor difference between patties with 5% and 10% spleen (P>0.05). Chewiness scores were not different between the patties (Table 2) (P>0.05). The beef patties with 15% spleen had a significantly different flavor than beef patties prepared with less spleen or without spleen. The overall acceptability scores of the patties with 5% spleen and control patties were similar (P>0.05). Control patties were the most acceptable, overall, while patties with 15% spleen had the lowest overall acceptability (5.68±0.24 and 5.06±0.30, respectively). Addition of 5% spleen did not produce a negative impact on sensory properties. However, with the higher percentages of spleen in the patty formulations resulted in lower sensory scores of the patties, except that of odor. Krishnan and Sharma (1990) reported that offal (rumen and heart meat in equal proportions) in buffalo meat sausages did not produce any negative effect on sensory properties (appearances, color, flavor, juiciness and overall acceptability).
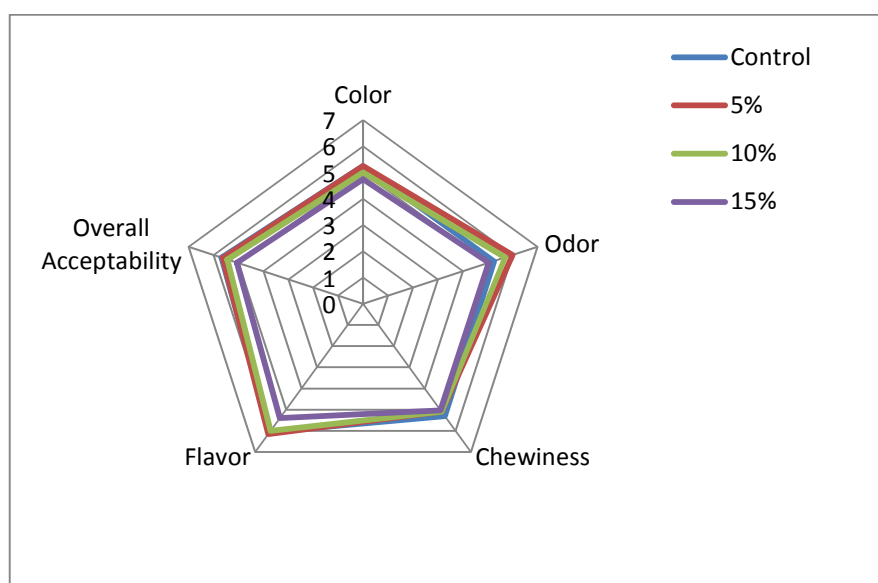
Control: beef patties without spleen; 5%: beef patties with 5% spleen, 10%: beef patties with 10% spleen; 15%: beef patties with 15% spleen
Figure 1. Sensory properties (color, odor, chewiness, flavor and overall acceptability) of beef patties.

4. Conclusion

Spleen is a food (along with liver) recommended by the medical profession for the treatment of iron deficiency anemia. The development of beef patties fortified with the spleen could help older adults, pregnant women and infants achieve their targeted iron requirements, thus reducing the risk of anemia. Our study on the physico-chemical properties of the patties with spleen showed that increasing the percentage of spleen incorporated in the beef patties does not affect b* (yellowness) or pH, while the L* (lightness) and a* (redness) values decrease, but iron content increases. The findings from this research showed that beef patties with 5% spleen and control patties (no spleen) were similarly favorably assessed in terms of sensory scores. Spleen has potential to be used to successfully enrich beef patties with iron, providing a new and healthier product.

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