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# Effects of liquid smoke on quality characteristics of Turkish standard smoked beef tongue

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**Abstract**

The purpose of this research was to determine some quality characteristics of beef tongues processed with liquid and vaporous (traditional) smoke. The tongues were divided into two groups; traditional (vaporous) smoking and liquid smoke application groups, and the processed tongues were vacuum packaged and monitored for quality during 30 days of storage at 4±1 °C. All the smoked tongue samples were subjected to chemical, microbiological and organoleptic analysis at 0, 5, 10, 15 and 30 days of storage. The results indicated that despite some favorable results attributed to traditional smoking, liquid smoke application of beef tongue is also possible without causing any major acceptability problems in terms of quality.
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## 1. Introduction

Animal by-products with economic value obtained from animals are classified as either edible or inedible food merchandises for humans consumption. Edible tissues like tongue, liver, heart and tripe can be used fresh, cured and smoked, canned or as ingredients in many comminuted processed meat products (Judge, Aberle, Forrest et al., 1989). The tongue is rich in good quality protein and may be very beneficial nutritionally. Hence one important meat producty is cured and smoked tongues.

While pork, sheep and calf tongues are processed on occasions, beef tongues are usually cured and smoked before they are sold (Pearson & Tauber, 1984).

When the tongues are removed from the root of the mouth cavity, they are graded on surface integrity, color and defects which include cuts on the membrane, warts and physical abnormalities or diseases. The most desirable tongues are white and free from defects. Regulations require that tongues are to be clean, free from diseases and scalded to remove the mucous membrane before processing. During tongue processing, generally, the tip of the epiglottis, larynx, trachea, salivary glands (except sublingual), excessive fat, hyoid bones and cartilages of the tongues are removed and the tongue is washed/cleaned. Then the tongues are stitch or artery pumped for pickle curing or subjected to brine curing by long immersion (Yetim, 2000). Generally, a half of the brine is injected and then they are soaked for 3 days in the rest of the solution at approximately 3 °C to loosen the mucous coating and allow cure diffusion. Afterwards the tongues are washed, smoked and cooked by long term moist-heat to an internal temperature of at least 67 °C (frequently to 82 °C) usually requiring 5–6 h. However, not all the tongues are cooked, some are cured and sold raw (Ockerman & Hansen, 1988; Pearson & Dutson, 1992). For example, the Turkish standard smoked beef tongue, the subject of this research is a type of cured, smoked and cooked tongue that differs from the canned meat product described as normal cured tongue by Ranken (2000) which is well known in Europe and North America.

Research on tongues has been limited. Frentz (1978) described the preparation of cured smoked beef products while Miller (1988) evaluated the physical and

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sensory properties of jerky processed from beef tongue. Some studies have been conducted on unprocessed tongue and similar types of meat; for example, Bersani, Cattaneo, Balzaretti, and Cantoni (1984) investigated psychrotrophic enterobacteriacea occurring in refrigerated tongues, and the effects of lactic acid decontamination and vacuum packaging on the quality of veal tongues were studied by Visser, Koolmees, and Bijker (1988). The most recent report relating to tongue was concerned with microbiological contamination in beef tissues conducted by Delmore, Sofos, Schmidt et al. (2000). Their results showed that acetic acid (2%) spraying, lactic acid (2%) immersion, and hot water (78–80 °C) spraying for 10 s were among the most effective treatments for reducing APCs, total coliform counts, and *E. coli* counts on a variety of meats including tongue.

In meat processing, it is highly desirable to reassess the potential tissues for making edible and attractive foods from the substantial amount of slaughterhouse products that are often wasted. Cured-smoked tongue has high biological and economical value and relies heavily on conventional processing procedures. Nonetheless, traditional vaporous smoking of meat products has often been replaced by use of natural liquid smoke flavorings (Yabiku, Martins, & Takahashi, 1993; Yetim, 2000). As some carcinogenic compounds such as 3-4 benzpyrene and 1,2,5,6 phenanthracene have been isolated from natural smoke work has been done to produce carcinogen-free smoke flavor. For instance, liquid smoke provides a greater uniformity of flavor and color without the inconvenience of sawdust handling or smokehouse clean up. Also the emission problems of traditional smoking have been eliminated since tar, resins and benzpyrenes are removed from the natural smoke by filtration, distillation and aging (Kolsarici & Guven, 1998; Gonulalan, Arslan, & Dincoglu, 1999; *Liquid smoke application to hams and picnics*, 1991; Yetim, 2000). So it is possible to produce safer, economical and uniform smoked meat products using liquid smoke. The purpose of this research was to investigate the effects of liquid smoke on some quality characteristics of cured/smoked beef tongues.

## 2. Materials and methods

### 2.1. Smoked cured tongue processing

The experimental smoked tongues were prepared in Erciyes University Safiyecikrikci Vocational School meat research laboratory following the procedure Turkish Smoked Tongue (*Rules for processing of smoked tongue*, 1990). A total of 10 beef tongues were used in this experiment, and the tongues were from young bulls (2±0.5 years old), from the same herd, and slaughtered in Kayseri Meat Plant. Liquid smoke was purchased from Gewürz Mühle Nesse Inc. and was produced from Hickory (Art. Nr. 10550).

In the processing, the tip of the epiglottis, larynx, trachea, salivary glands, excessive fats, hyoid bones and cartilages of the tongues were removed, and the tongues were washed thoroughly. The tongues were subjected to artery and long immersion curing. Initially, a 5% (weight) of brine (containing 4.5 kg NaCl, 250 g Na-isoascorbate, 68 g $NaNO_3$ and 68 g $NaNO_2$/45 l tap water of 7.6 pH) was pumped through the lingual arteries, and then the tongues were soaked in same brine for 5 days at a temperature of 4±1 °C. Then the cured tongues were rewashed with tap water and placed in cooking bags and autoclaved for 3 h at 100 °C (*Rules for processing of smoked tongue*, 1990). The cured/cooked tongues were then divided into two groups; one group was subjected to traditional smoking in a chamber for 5 h at 80 °C while the other was spray treated by liquid smoke (Kolsarici & Guven, 1998). The smoked tongues were cooled, vacuum packaged and stored at 4±1 °C for 30 days. The samples were subjected to microbiological, chemical and sensory analysis at 0, 5, 10, 15 and 30 days of storage.

### 2.2. Enumeration of microorganisms

Total aerobic bacteria (APC), psychrotrophic bacteria, yeasts and moulds, total coliforms, staphylococcus/micrococcus, halophiles and lactic acid bacteria counts were determined according to BAM (1998) procedure and reported as log cfu/g where appropriate. Total aerobic counts were determined on Plate Count Agar (PCA) incubated at 35 °C for 48 h, and psychrotrophs were determined on PCA after incubation at 5 °C for 10 days. The yeasts and moulds were counted on Potato Dextrose Agar (PDA) after 5 days of incubation at 23 °C. The number of coliforms was determined with violet red bile agar (VRBA) after incubation at 35 °C for 24 h. The number of total staphylococci/micrococci was tested by mannitol salt agar and the plates were incubated at 37 °C for 30 h. Halophiles were determined with Plate Count Agar containing 15% NaCl and incubated at 35 °C for 3 days.

### 2.3. Chemical properties

Chemical properties of the smoked tongues such as pH and TBA values, nitrosomyoglobin conversion rate (% NCR) as well as moisture and salt contents were determined by AOAC (1990) methods.

### 2.4. Organoleptic characteristics

Organoleptic characteristics of the beef tongues were evaluated using a 9-point hedonic scale for: texture,

color, flavor/aroma, and general appearance. For this purposes, five to seven panelists were used to evaluate the tongues as described by AMSA (1978).

### 2.5. Statistical analysis

The collected data from two replications was subjected to a *t*-test to determine the differences between liquid and traditional smoke treatments (independent variable) for each parameter in each period. The General Linear Model Repeated Measures was used to determine the differences between each period (independent variable) for each parameter, using the SPSS statistical package. Significantly different treatment means were further separated using the LSD method, and significance was reported at $P<0.05$ with means-±SE (Duzgunes, 1975).

## 3. Results and discussion

### 3.1. Chemical analysis

No major differences were observed in chemical properties between the tongues samples produced by both smoking methods during storage, despite some numerically significant differences. For example, moisture contents of the liquid and traditionally smoked tongues were not different ($P>0.05$), and were in the range of the Turkish Standard for moisture content (42–57%) specified for smoked tongues. However, statistically significant differences ($P<0.05$) for moisture content were determined with storage and were lowest at day 30 of storage. At the beginning, moisture content of liquid and traditionally smoked groups were 59.58 and 59.41%, respectively, while they were 52.93 and 52.01% at the end of the storage (Table 1). Salt contents of the liquid and traditionally smoked tongues were also not different ($P>0.05$) but the % salt content increased significantly during storage. The values were in the range of standard Turkish Smoked Tongue, which averages 2.5% [Füme (Dumanlanmis) Dil, 1995] while Soyutemiz, Anar, and Berkes (1992) reported slightly higher salt contents (3.15%) in their traditionally smoked beef tongues.

Immediately after smoking, TBA value of the liquid smoke applied group was 0.379 mg MA/kg compared with 0.384 mg MA/kg for the traditionally smoked tongues, and these values increased to 0.911 and 0.701 mg MA/kg at the 30th day of storage respectively, the differences were statistically significant ($P<0.05$) Table 1. This difference might be due to the anti-oxidative components in the smoke, with the natural smoke being more effective in terms of retarding oxidation. However, the TBA values measured in all of smoked tongues were acceptable for meat products (Gokalp, Kaya, & Zorba, 1995).

The mean pH value of liquid smoked tongues was 6.36 after production compared to 6.35 in the traditionally smoked tongues (Table 1). However, these values fell to 6.10 and 6.28, respectively, at the end of storage (30th day), and the differences were statistically significant ($P<0.05$). The difference in pH could be due to the level/activity of lactic acid bacteria and the

Table 1
Effects of smoking method on some chemical characteristics of smoked beef tongue

| | 0 day $X$±SE | 5th day $X$±SE | 10th day $X$±SE | 15th day $X$±SE | 30th day $X$±SE |
|---|---|---|---|---|---|
| *% Moisture* | | | | | |
| Liquid smoke | 59.58A±0.22 | 59.37A,a±0.27 | 58.92A,a±0.14 | 56.38 B±0.27 | 52.93C±0.28 |
| Traditional | 59.41A±0.46 | 58.15A,B,b±0.23 | 56.44B,C,b±0.64 | 55.67C±0.42 | 52.01D±0.55 |
| *% Salt* | | | | | |
| Liquid smoke | 2.33C±0.02 | 2.41B±0.03 | 2.44B±0.04 | 2.47B±0.05 | 2.69A±0.01 |
| Traditional | 2.34C±0.01 | 2.41B,C±0.03 | 2.43B±0.04 | 2.47B±0.05 | 2.68A±0.02 |
| *TBA* | | | | | |
| Liquid smoke | 0.379E±0.01 | 0.463D,a±0.07 | 0.668C,a±0.07 | 0.769B,a±0.01 | 0.911A,a±0.09 |
| Traditional | 0.384E±0.004 | 0.409D,b±0.005 | 0.555C,b±0.003 | 0.661B,b±0.01 | 0.701A,b±0.01 |
| *pH* | | | | | |
| Liquid smoke | 6.36E±0.003 | 6.24D,a±0.002 | 6.15C,a±0.01 | 6.18B,a±0.002 | 6.10A,a±0.002 |
| Traditional | 6.35E±0.002 | 6.29D,b±0.003 | 6.39C,b±0.002 | 6.20B,b±0.004 | 6.28A,b±0.005 |
| *% NCR* | | | | | |
| Liquid smoke | 24.57E,a±0.33 | 26.02D,a±0.13 | 30.85C,a±0.32 | 35.90B,a±0.27 | 39.62A±0.33 |
| Traditional | 22.24E,b±0.42 | 24.75D,b±0.14 | 36.59C,b±0.33 | 38.52B,b±0.14 | 39.82A±0.10 |

NCR: Nitrosomyoglobin Conversion Rate, TBA: Thio Barbutiric Acid (mg Malon Aldehyde/kg). Different uppercase letters (A,B) in a row show significant difference between the groups ($P<0.05$). Different lowercase letters (A–E) in a column shows significant difference between the liquid and traditional smoke treatments ($P<0.05$).

amount of organic acid deposition in the liquid smoke (Gokalp et al., 1995; Goktan, 1990). Soyutemiz et al. (1992) reported similar results (6.24) for the pH values in traditionally cured smoked beef tongues. In this study, mean values for pH were in accordance with Turkish Smoked Tongue Standards, between 5.0 and 6.5 [Füme (Dumanlanmis) Dil, 1995]. At the beginning, nitrosopigment conversation were 24.57 and 22.24% in liquid and natural smoke applied groups, respectively. These values increased with storage, and at 30 days storage, they reached 39.62 and 39.82% for the liquid and traditionally smoked tongues respectively. Also, statistically significant differences were seen for nitrosomyoglobin conversation during storage and between the groups (Table 1).

### 3.2. Microbiological analysis

Microbiological analyses showed that none of the tongue samples had coliform and yeasts and mould at any storage time, and the only difference detected initially between the liquid and traditionally smoked tongues was for APC. At the beginning, liquid and traditionally smoked samples had 1.08–1.10, 1.55–1.70, 1.00–1.05, 1.09–1.05 and 2.14–2.20 log cfu/g for total staphylococci/micrococci, APC, phsycocrotrophs, halophiles and lactic acid bacteria, respectively (Table 2). Anar, Soyutemiz, Berker, and Eyigor (1992) reported $1.2\times10^3$ APC and $4.2\times10^2$ lactic acid bacteria immediately after the smoking of beef tongues. The microorganisms counted on all samples increased with storage (Table 2). Statistically significant ($P<0.05$) differences were detected due to storage and between the groups for some bacteria (Table 2). The differences are expected with storage however, the reason for the differences between the liquid and traditionally smoked samples might be related to the efficiency smoking. In the Turkish Smoked Tongue Standard, the upper limit for APC is $10^5$ cfu/g, and the values determined in this research were less than this limit [Füme (Dumanlanmis) Dil, 1995].

### 3.3. Sensory analysis

In general, traditionally smoked tongue samples received higher sensory scores at all times (Table 3), and the differences were statistically significant ($P<0.05$) in most cases. For example, traditionally smoked tongue samples received increasing scores with storage time for flavor and aroma, the scores being 7.00 and 8.67 at 0 and 30 days of storage, respectively, while these values were 6.33 and 7.33 for the liquid smoked tongues, respectively, these differences were significant ($P<0.05$)

Table 2
Effects of smoking method on some microbiological characteristics of smoked beef tongue (Log cfu/g)

| | 0 day $X\pm$SE | 5th day $X\pm$SE | 10th day $X\pm$SE | 15th day $X\pm$SE | 30th day $X\pm$SE |
|---|---|---|---|---|---|
| *Total coliforms* | | | | | |
| Liquid smoke | <1.0×101 | <1.0×101 | <1.0×101 | <1.0×101 | <1.0×101 |
| Traditional | <1.0×101 | <1.0×101 | <1.0×101 | <1.0×101 | <1.0×101 |
| *Staphylococcus/micrococcus* | | | | | |
| Liquid smoke | 1.08D±0.03 | 1.53C,a±0.02 | 1.57C,a±0.02 | 2.17B,a±0.02 | 2.45A,a±0.07 |
| Traditional | 1.10D±0.04 | 1.21D,b±0.21 | 1.45C,b±0.15 | 2.31B,b±0.07 | 2.43A,b±0.14 |
| *APC* | | | | | |
| Liquid smoke | 1.55D,a±0.02 | 1.45E±0.02 | 1.82C,a±0.05 | 3.08B±0.07 | 4.21A±0.29 |
| Traditional | 1.70D,b±0.05 | 1.37E±0.07 | 2.19C,b±0.04 | 2.96B±0.13 | 4.26A±0.08 |
| *Psychrotrophics* | | | | | |
| Liquid smoke | 1.00E | 1.27D±0.01 | 3.06B,a±0.04 | 2.75C,a±0.07 | 4.01A,a±0.12 |
| Traditional | 1.05C±0.02 | 1.42B±0.10 | 1.46B,b±0.08 | 1.92A,b±0.05 | 1.72A,b±0.07 |
| *Halophiles* | | | | | |
| Liquid smoke | 1.09C±0.03 | 1.01D±0.01 | 1.01D,a±0.004 | 1.69B±0.05 | 4.56A±0.07 |
| Traditional | 1.05D±0.02 | 1.02E±0.01 | 1.49C,b±0.06 | 1.79B±0.06 | 4.54A±0.10 |
| *LAB* | | | | | |
| Liquid smoke | 2.14C±0.02 | 1.47E,a±0.02 | 1.57D,a±0.01 | 3.08B±0.08 | 4.86A,a±0.04 |
| Traditional | 2.20C±0.02 | 1.64E,b±0.05 | 1.79D,b±0.01 | 3.08B±0.23 | 4.53A,b±0.10 |
| *Yeast and mold* | | | | | |
| Liquid smoke | <1.0×101 | <1.0×101 | <1.0×101 | <1.0×101 | <1.0×101 |
| Traditional | <1.0×101 | <1.0×101 | <1.0×101 | <1.0×101 | <1.0×101 |

APC: Aerobic Plate Count; LAB: Lactic Acid Bacteria. Different uppercase letters (A–E) in a row shows significant difference between the groups ($P<0.05$). Different lowercase letters (a,b) in a column show significant difference between the liquid and traditional smoke treatments ($P<0.05$).

Table 3
Effects of smoking method on some sensory characteristics of smoked beef tongue

| | 0 day $X \pm$SE | 5th day $X \pm$SE | 10th day $X \pm$SE | 15th day $X \pm$SE | 30th day $X \pm$SE |
|---|---|---|---|---|---|
| *Flavor/aroma*[a] | | | | | |
| Liquid smoke | 6.33B,a±0.23 | 6.00B,a±0.17 | 5.83B,a±0.21 | 6.33B,a±0.23 | 7.33A,a±0.33 |
| Traditional | 7.00D,b±0.17 | 7.33C,b±0.14 | 7.67B,b±0.14 | 8.50A,b±0.15 | 8.67A,b±0.14 |
| *Texture*[b] | | | | | |
| Liquid smoke | 7.17B,a±0.21 | 7.67A±0.14 | 6.00D,a±0.17 | 6.67C,a±0.14 | 6.33C,D±0.14 |
| Traditional | 7.83A,b±0.21 | 8.00A±0.17 | 8.17A,b±0.27 | 8.67A,b±0.28 | 6.50B±0.15 |
| *Color*[c] | | | | | |
| Liquid smoke | 8.17A±0.21 | 7.67A±0.14 | 8.17A,a±0.11 | 6.67B,a±0.28 | 6.67B,a±0.14 |
| Traditional | 8.33B±0.14 | 7.83B±0.27 | 9.33A,b±0.14 | 8.50B,b±0.15 | 7.83B,b±0.27 |
| *General*[d] *Appearance* | | | | | |
| Liquid smoke | 7.00A±0.30 | 6.83A,a±0.27 | 6.17C,a±0.21 | 6.50B,a±0.23 | 6.17C,a±0.11 |
| Traditional | 7.67B±0.14 | 8.33A,b±0.14 | 7.83A,b±0.11 | 8.00A,b±0.25 | 7.17B,b±0.11 |

Different uppercase letters (A–D) in a row shows significant difference between the groups ($P < 0.05$). Different lowercase letters (a,b) in a column show significant difference between the liquid and traditional smoke treatments ($P < 0.05$).

[a] A1 = Atypical flavor and aroma, 9 = Typical flavor and aroma.
[b] 1 = Very coarse, 9 = Very fine texture
[c] 1 = Undesired color, 9 = desired color.
[d] 1 = Undesirable appearance, 9 = Very desirable appearance.

for both storage time and treatment. Traditionally smoked tongues also generally received higher scores for texture, color and general appearance compared with liquid smoked ones and the difference was statistically significant ($P < 0.05$) at some storage times (Table 3). Thus traditionally smoked tongue samples generally had better scores for all sensory characteristics at all times than the liquid smoked counterparts. However, all sensory scores were in the acceptable range.

## 4. Conclusions

The results, showed that there were no large differences between the traditional vaporous and liquid smoked tongues in terms of chemical, microbiological and sensory properties. Although the traditional smoke application gave slightly better results liquid smoke application might have several advantages over traditional smoking in terms of environmental pollution, cost, product uniformity and wholesomeness are applied.

## References


AMSA. (1978). *Guidelines for cookery and sensory evaluation of meat*. Chicago, IL: American Meat Science Assoc. and National Live Stock & Meat Board.

Anar, S., Soyutemiz, G. E., Berker, A., & Eyigor, A. (1992). Fume Dillerin Uretim Asamalarinda Olusan Bazi Mikrobiyolojik Degisimlerin Incelenmesi. *Uludag Universitesi Veteriner Fakultesi Dergisi*, *2*(11), 53–59 (Turkish).

AOAC. (1990). *Official methods of analysis* (15th ed.). Washington, DC: AOAC.

BAM. (1998). *Bacteriological analytical manual* (8th ed.). Gaithersburg, MD, USA: BAM.

Bersani, C., Cattaneo, P., Balzaretti, C., & Cantoni, C. (1984). Psychrotrophic Enterobacteriaceae occurring in refrigerated meat products. *Index Alimentarius*, *23*(213), 112–118.

Delmore, R. J., Sofos, J. N., Schmidt, G. R., Belk, K. E., Lloyd, W. K., & Smith, G. C. (2000). Interventions to reduce microbiological contamination of beef variety meats. *Journal of Food Protection*, *63*(1), 44–50.

Duzgunes, O. (1975). *Istatistik Metotlari*. Ankara, Turkey: Ankara Universitesi Ziraat Fakultesi Yayin No. 578 (Turkish).

Frentz, J. C. (1978). Cured and cooked beef products. *Euroviande Courrier Abattoir*, *19*(108), 19–26.

*Füme (Dumanlanmis) Dil, TS 11523*. (1995). Ankara, Turkey: Turk Standardlari Enstitusu Kurumu (Turkish).

Gokalp, H.Y., Kaya, M., & Zorba, O. (1995). *Et Urunleri Isleme Muhendisligi* (pp. 417–436). Erzurum, Turkey: Ataturk Universitesi Ziraat Fakultesi Yayin No. 786 (Turkish).

Goktan, D. (1990). Gidalarin Mikrobiyal Ekolojisi. *I. Et Mikrobiyolojisi*. (pp. 32–35). Izmir, Turkey: Ege Universitesi Muhendislik Fakultesi Yayin No. 21 (Turkish).

Gonulalan, Z., Arslan, A., & Dincoglu, A. H. (1999). Gida Kaynakli Karsinojenler. *Erciyes Universitesi Saglik Bilimleri Enstitusu Dergisi*, *8*(1-2), 47–55 (Turkish).

Judge, M. D., Aberle, E. D., Forrest, J. C., Hedrick, H., & Merkel, R. (1989). *Principles of meat science*. Dubuque Iowa: Kendal/Hunt Pub. Co.

Kolsarici, N., & Guven, T. (1998). The effects of using liquid smoke on storage stability of frankfurters. *Turkish Journal of Veterinary and Animal Sciences*, *22*, 379–388.

*Liquid smoke application to hams and picnics*. (1991). Manitowoc, WI, USA: Red Arrow Products Co. Inc.

Miller, M. F. (1988). Evaluation of the physical and sensory properties of jerky processed from beef heart and tongue. *Journal of Food Quality*, *11*(1), 63–70.

Ockerman, H. W., & Hansen, C. L. (1988). *Animal by-product processing*. Chichester, UK: Ellis Horwood.

Pearson, A. M., & Dutson, T. R. (1992). *Inedible meat by-products*. London: Advanced Meat Research, Vol. 8, Elsevier Applied Science.

Pearson, A. M., & Tauber, F. W. (1984). *Processed meats* (2nd ed.). New York: AVI Publication.

Ranken, M. D. (2000). *Handbook of meat product technology*. London UK: Blackwell Science.

*Rules for processing of smoked tongue, TS 8637*. (1990). Ankara, Turkey: Turk Standardlari Enstitusu Kurumu (Turkish).

Soyutemiz, G. E., Anar, S., & Berker, A. (1992). Fume Dillerin Uretim Asamalarinda Olusan Kimyasal Degisimlerin Incelenmesi. *Uludag Universitesi Veteriner Fakultesi Dergisi*, *2*(11), 153–158 (Turkish).

Visser, I. J. R., Koolmees, P. A., & Bijker, P. G. H. (1988). Microbiological conditions and keeping quality of veal tongues as affected by lactic-acid decontamination and vacuum packaging. *Journal of Food Protection*, *51*(3), 208–213.

Yabiku, H. Y., Martins, M. S., & Takahashi, M. Y. (1993). Levels of benzo [a] pyrene and other polycyclic aromatic hydrocarbons in liquid smoke flavor and some smoked foods. *Food Additives and Contaminants*, *10*(4), 399–405.

Yetim, H. (2000). *Kesimhane Urunleri Isleme Teknolojisi (Ders Notlari)*. Erzurum, Turkey: Ataturk Universitesi Ziraat Fakultesi Gida Muhendisligi Bolumu (Turkish).