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# Effect of salt and moisture content reduction on physical and microbiological properties of salted, pressed and freeze dried turkey meat

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ABSTRACT

The effect of salt content, pressing and moisture content on textural, micro structural and color characteristics, adsorption isotherms and microbiological count of turkey breast meat were studied. There were no statistically significant differences ($P \geq 0.05$) between samples including high salt-moisture and low salt-moisture for color (lightness, redness and yellowness) and textural properties of hardness, cohesiveness, springiness and chewiness parameters and they were determined as 59.10–65.76, 0.30–0.28, 1.27–1.19 and 22.44–22.21, respectively. Total mesophilic aerobic counts, *Micrococcus*/*Staphylococcus* counts and yeast/mold counts of samples including low salt and moisture were detected as 3.23, 0, 2.98 (log cfu/g) and they were lower than the same counts of samples including high salt and moisture which were found as 6.66, 6.69, 5.95 (log cfu/g) after 70 days of storage. The reduction of salt content did not increase the growth of these microorganisms if we also decrease the moisture content of turkey meat by freeze drying process. Increase of hardness of turkey meat by drying is not found related to shrinkages according to comparison of air and freeze drying. Reduction of moisture content to 40% reduced freeze dying time to 7 h from 27 h of complete drying in freeze dryer.



## 1. Introduction

The consumer demands for poultry products have increased in recent years because of being an economical protein sources containing less fat than red meat. Producers modified the red meat processes to poultry or other meats and created new products like poultry ham, bacon, hot dogs and dry-fermented sausages (Barbut, 2002; Kargozari et al., 2014). Traditional Turkish meat product Pastrami (Pastrami) is also a cured, pressed and partially dried meat product that can be produced by poultry meat. Salt is used to control microbial growth as if spice is used (Guler & Seker, 2009). There is an interest to reduce salt content of processed meat products to minimize effect of salt on hypertension and cardiovascular diseases (Askin & Kilic, 2009). On the other hand, reducing salt content enhance microbial growth during long drying period in conventional air drying (Uğuz, Soyer, & Dalmiş, 2011). The effects of low salt concentration on microbial growth during long drying period can be compensated by alternative drying methods and reducing the moisture content of product.

Pastrami has traditionally been made by drying meat at 15–20 °C in several days (Gök, Obuz, & Akkaya, 2008). Freeze-drying is a low temperature dehydration process that preserves the taste, color, appearance, texture, and dimensions while preventing oxidation and extending the shelf life of foods but it is a slow and consequently an expensive process. Therefore the use of this process is restricted to high value products (Babić, Cantalejo, & Arroqui, 2009; George & Datta, 2002; Lopez-Quiroga, Antelo, & Alonso, 2012). Previously, we studied the optimal control of freeze drying of pharmaceutical products (Sadikoglu, Ozdemir, & Seker, 2003). Freeze-drying can also be applied to expensive dried meat products like pastrami. Complete drying of meat with freeze drier is considered for production of soup and sauce base material (Babić et al., 2009). Partial drying of meat with freeze drier decreases production cost compared to complete drying and it may increase the application field but it has not been searched before. We examined fitness of freeze drying model of turkey breast meat with experimental results (Cumhur, Şeker, & Sadıkoğlu, 2015).

Microbial growth can be decreased by salting and reducing moisture content of meat product but these treatments also affect

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the texture of meat product. There is limited research papers in the literature about the effects of salt and moisture content varied with air drying on textural properties of meat muscle (Ruiz-Ramírez, Arnau, Serra, & Gou, 2005; Ruiz-Ramírez, Serra, Arnau, & Gou, 2005) while there is no study about texture profile analysis (TPA) of freeze dried turkey meat as pastrami. Beside texture, color of the meat products gives important information about the quality. Babić et al. (2009) studied the color properties of completely freeze dried and rehydrated chicken meat, Canto et al. (2012) examined the effect of hydrostatic pressure on color of refrigerated Caiman tail meat, and Uğuz et al. (2011) studied the effect of salt content on color properties of muscle. However, the effect of moisture content varied with freeze dryer on color of turkey meat has not been studied before. The other important safety and quality issue is the microbial stability of foods having a strong correlation with water content and water activity ($a_w$). The relationship between water content and $a_w$ is demonstrated by sorption isotherms which are used for product development, shelf life prediction and determination of package requirements depending on the products sensitivity to moisture gain or loss. Comaposada, Gou, Pakowski, and Arnau (2000) analyzed the effect of salt content on desorption isotherms of pork meat but the effect of salt content on the adsorption isotherms of freeze dried turkey meat has not been examined.

In this study, TPA and color parameters, microstructure analysis with Scanning Electron Microscopy (SEM), the adsorption isotherms and microbiological count of freeze dried turkey meat including high salt-moisture or low salt-moisture were studied to determine if it is possible to produce a low salted turkey meat product by reducing moisture content in freeze dryer without reducing microbiological and physical quality.

## 2. Materials and methods

### 2.1. Raw material and sample preparation

All measurements were made on Bolca (Bolu, Turkey) brand's turkey breast meat which was stored at 4 °C until usage. The meat samples were prepared for salting process after removing the fatty parts and cutting parallel to fiber direction. The thickness of the samples were determined as 10 mm for only salted products (S) and 20 mm for salted and pressed products (SP) by an electronic digital caliper (Fred Fowler Co., Newton, MA) because the samples become thinner after pressing.

Samples were placed between 10 mm thickness of coarse salt layer and salted to different salt levels (4–5% and 7–8% on dry base) with dry salting. After salting process, the samples were washed and dried on paper towels to eliminate excess salt. Samples were pressed with weight of 10 kg which is put onto each sample with dimensions of about 60 × 90 × 20 mm (approximately 80 g) for 16 h. Meat samples release some water with pressing. Moisture content of products was measured according to method of Wiklund, Kemp, Li, and Wu (2010) and salt content of samples was determined by Mohr's method (Kirk & Sawyer, 1991). Table 1 shows the name of the samples with their salt and moisture contents.

Salted and salted-pressed samples were freeze dried until desired moisture contents with a pilot scale freeze drier (VirTis Ultra 25 Super XL, New York, USA). In all experiments, the freeze drier shelf temperature was maintained at −40 °C for freezing and 20 °C for drying step. Heat flows perpendicular to fiber direction. In drying step the chamber pressure was set at 10 Pa.

### 2.2. Texture profile analysis (TPA)

Textural properties of samples were examined using Texture Analyzer Model TA Plus (Lloyd Instruments, Hampshire, UK) with 1 kN load cell and data was interpreted using Nexygen™ (NexyGen Plus, Lloyd Instruments, Hampshire, UK) software. Cylindrical subsamples (14.5 mm diameter and 10 mm height) were prepared from every meat sample by using a sharp cylindrical apparatus. A double compression test was applied to 30% compression of their original height with a cylindrical shaped probe of 25 mm diameter. The crosshead speed was set to 0.5 mm $s^{-1}$.

### 2.3. Microstructure analyses

Microstructures of samples were observed by SEM (XL-30 SFEG, Philips, Eindhoven, Holland). S and SP samples were completely freeze dried until constant mass. Samples with dimension of 5 × 2 × 5 mm were coated with gold by using Sputter Coater SC7620 (Quorum Technologies Ltd., Lewes, UK) before the analysis.

### 2.4. Color measurement

Color values of samples were measured by using a Konica Minolta CM-5 colorimeter (Osaka, Japan) according to CIELab system (L*: lightness, a*: redness, and b*: yellowness). Measurements were evaluated at four points in central and lateral locations of samples and average results were given.

### 2.5. Sorption isotherms

Sealed glass jars which were containing different saturated salt solutions (LiCI, $MgCl_2$, $Mg(NO_3)_2$, NaCI, $BaCl_2$) to provide $a_w$ between 0.11 and 0.92 were used for gravimetric determination of adsorption isotherms (Greenspan, 1977; Rahman & Sablani, 2009). Triplicate subsamples were taken from completely freeze dried meat samples and they were placed into the jars within weighted petri dishes (Bell & Labuza, 2000). Small quantity of toluene was also added to each jar to inhibit fungal activity (Kaymak-Ertekin & Gedik, 2004). Adsorption isotherms were determined at 15 °C with temperature controlled cabinet having ±1 °C accuracy. The samples were weighted until desired equilibrium water content to be reached when the weight changes was as small as 0.001 g.

### 2.6. Microbiological analyses

Salted-pressed samples including low salt content (SP1) and high salt content (SP2) with high moisture and salted-pressed samples including low salt content with low moisture (SP3) were used to analyze the effects of salt contents and moisture contents on microbial counts of freeze dried products during the storage. Samples were individually overwrapped with polyvinyl-chloride film (thickness: 0.04 mm) by an impulse sealer. A 10 g of sample were transferred into a stomacher bag under aseptic conditions, and homogenized with 90 mL of sterile physiological saline (0.85% NaCI) in a laboratory blender (BagMixer 400 V W, Interscience, France) for 3 min. Serial decimal dilutions were prepared in the sterile physiological saline and 0.1 ml of appropriate dilutions was spread in triplicate onto agar plates. Total aerobic mesophilic (TAM) bacteria count was enumerated on a Plate Count Agar (PCA, Merck) at 30 °C for 72 h. Yeast and molds were incubated aerobically on Potato Dextrose Agar (PDA, Merck) at 25 °C for 5 days. *Micrococci* and *staphylococci* were determined on Mannitol Salt Phenol-Red Agar (MSA, Merck) by incubation at 30 °C for 48 h. *Enterobacteriacea* were incubated on Violet Red Bile Dextrose Agar (VRBD, Merck) at 30 °C for 48 h in anaerobic conditions.