



## Effect of Modified Atmosphere Packaging on the Refrigerated Storage of Manti

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### ABSTRACT

Manti, the traditional Turkish food, was subjected to modified atmosphere packaging (MAP) compositions of MAP 1 (80% CO<sub>2</sub> + 20% N<sub>2</sub>), MAP 2 (40% CO<sub>2</sub> + 60% N<sub>2</sub>), MAP 3 (60% CO<sub>2</sub> + 40% N<sub>2</sub>) and control (packaged under atmospheric composition) to extend its refrigerated storage at 4°C. The physical, chemical and sensorial qualities of each package were assessed by analysing headspace gas composition, pH, water activity, 2-thiobarbituric acid (TBA), dry matter, lipid content and a sensory analysis of both cooked and raw manti samples. The compositions of MAP samples (MAP 1, MAP 2 and MAP 3) resulted in the maximum storage time of 126 days versus 20 days in normal atmospheric packaging (control). In conclusion, 60% CO<sub>2</sub> or either 80% CO<sub>2</sub> with N<sub>2</sub>, as a make-up gas, should be implemented in the manti process.

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### Introduction

Manti, the traditional Turkish food, is commonly consumed as a nutritious product in Turkey. Manti stuffing typically consists of specific proportions of minced beef meat, onion, paprika, black pepper and salt. Approximately, one-quarter of the water used for the preparation of dough is added to a mixture of wheat flour and salt during a hand-kneading process. A preheat treatment is applied according to consumer/retailer preferences before cooking. Cooking is generally applied in boiling water for 10–15 minutes, and then it is served with tomato sauce and garlic yoghurt sauce and some dried mint and sumac (Sitti et al., 2009; Öztürk et al., 2009).

When combined with cold storage, MAP provides stable food products for long term storage. In the literature, studies reported effect of MAP gases (CO<sub>2</sub> and N<sub>2</sub>) in cold storage on the shelf life of raw beef (Ho et al., 2003; Barrera et al., 2007; Gökoğlu et al., 2011; Carola et al., 2013) and ravioli, cannelloni and tortellini, which are similar to manti (McGuire et al., 1989; Liggett et al., 1990; Giannuzzi, 1998; Sanguinetti et al., 2011).

Therefore, the current research was performed to determine the refrigerated storage of modified atmosphere packed manti at 4°C by measuring physical, chemical and sensory parameters.

### Materials and methods

#### Manti Samples

Wheat flour, minced beef meat, dry onion, black pepper, salt and water were used as the raw materials of manti and purchased from a local market in Antalya (Turkey). Dough was prepared by mixing wheat flour and water at a 2:1 ratio (w/v) to obtain 0.1925 mm average sheeted dough by using a dough roller manually. The filling was prepared by mixing minced beef, kneaded dry onion (5%w/w of manti), salt (2%w/w of manti) and black pepper (0.5%w/w of manti). Stuffing material was filled to each square of dough (30 mm<sup>2</sup>) in an equal amount, which averaged 1.275 grams. The heat treatment was performed in an oven (Inoksan, Bursa/Turkey) with a product centre temperature of 60°C and treatment time of four minutes. The temperature was monitored by using a manual thermo logger. The product was left to cool at ambient temperature (~20°C) and immediately transported at 4°C within a van for MAP treatments.

#### MAP Application

The samples of manti were packaged under different gas combinations at the plant Antalya Altın Et Entegre Tesisleri, Turkey. Samples were placed in polypropylene trays with a water vapour transmission rate of ≤1 cc/tray/day and trays were sealed with a 25 μ thick polyolefin based film, an oxygen transmission rate of 24

cm<sup>3</sup>/m<sup>2</sup>/day/bar and with an 18 g/m<sup>2</sup>/day (38°C, 100% RH) water vapour transmission rate. MAP was carried out using G. Mondini (Italy) packaging machine. Sealing temperature was 150°C and a 2/1 (v/w) gas volume to manti ratio in each pack was applied. Gas mixtures were designed for MAP 1 (80% CO<sub>2</sub> + 20% N<sub>2</sub>), MAP 2 (40% CO<sub>2</sub> + 60% N<sub>2</sub>), MAP 3 (60% CO<sub>2</sub> + 40% N<sub>2</sub>) and control (78% N<sub>2</sub> + 20.8% O<sub>2</sub>) treatments. Samples from MAP1, MAP 2 and MAP 3 were stored at 4°C, 50–63% RH for 126 days. Control samples were stored at 4°C, 50–63% RH until they reached the spoilage period, then mould mycelia inside the tray was observed. Analyses were performed on days 0, 1, 3, 5 and 7 and then at seven day intervals up to the day 126.

#### *Physical, Chemical and Sensory Analysis*

The gas composition of headspace in packages was measured using a digital Oxybaby M (Germany) gas analyser and expressed as CO<sub>2</sub>% and O<sub>2</sub>%. The remaining gas was N<sub>2</sub>; pH of the whole sample (filling and dough) was determined using the Association of Analytical Communities (AOAC) method. 10 grams of sample were homogenised in 90 mL of distilled water and pH value were recorded by using pH meter (P Selecta pH 2001, Spain) averaging 3 measurements. Water activity (aw) of the whole samples was measured using a water activity meter (Novasina, Labmaster model, Switzerland).

10 grams of each whole sample was blended with 50 mL of distilled water in a Waring blender for 2 minutes for TBARS (thiobarbituric acid reactive substances) analysis. The mixture transferred quantitatively into Kjeldahl tubes by washing with an additional 47.5 mL of distilled water. 4 N 2.5 mL HCl was added and distilled up to a 200 mL final distillate. 5 millilitres of distillate mixed with 5 mL 0.02 M TBA reactive using vortex (100 mL TBA reactive was prepared by 90 mL glacial acetic acid and 10 mL distilled water). For blank 5 mL TBA reactive was mixed with 5 mL distilled water. Each tube was immersed in boiling water bath for 35 minutes and cooled at tap water for 10 minutes. Optical density was read against the blank at a wavelength of 538 nm using a spectrophotometer (Shimadzu UV-1700 Pharmaspec, Japan). Data were multiplied by the factor 7.8 to convert the mg of malonaldehyde per 1000 grams of the whole sample (Anonymous, 2009).

The dry matter content of manti samples were determined as follows: 5 grams of each whole samples were grinded and weighed into a constant weight aluminium caps. Thereafter, samples were dried in an oven at 105°C for overnight until the samples reached to a constant weight (Cemeroğlu, 2007).

To determine lipid content of the samples 10 grams of whole sample was blended with 200 mL of chloroform/methanol (2:1) in a Waring blender for 3 minutes at low speed. Homogenate was filtered through a Whatman Filter No. 1 paper into a 500 mL separating funnel. Filtrate was re-extracted with 50 mL of chloroform/methanol (2:1) and again filtered through the same filter paper. Blender and filter paper were rinsed twice with 20 mL of chloroform/methanol (2:1). A 60 mL

portion of 0.72% KCl was added to the solution in the separating funnel and the contents were mixed. After phase separation, lipid layer was separated and another 20 mL of 0.72% KCl was added. The lipid phase after phase separation was filtered through a Whatman No. 1 filter paper with anhydrous Na<sub>2</sub>SO<sub>4</sub> into a 200 mL volumetric flask. From this extract an aliquot of 10 mL was taken to a flask and solvent evaporated in boiling water. Flask was dried in an oven at 100°C for one hour and total lipid content was determined gravimetrically (Baggio et al., 2002).

The water vapour transmission rate of the tray was measured at 38°C/90% RH using the ASTM F-1249 method (Anonymous, 2011). The oxygen transmission rate of the film was measured at 23°C according to the ASTM D-3985 method (Anonymous, 2010). Those analyses were performed at TUBITAK MAM (The Scientific and Technological Research Council of Turkey Marmara Research Center), Gebze facilities.

Sensory analysis was performed with nine trained panellists in cooked manti (samples cooked in boiling water and held for seven minutes when the product centre temperature reached 80°C) scored it in the range of 1–5 points for appearance, flavour and odour, texture and taste. In raw samples appearance, texture, flavour and odour were evaluated. The panel room was odourless, had a hand washing stand and the lighting and room temperature (20–22°C) were uniform. Water was provided to panellists after each taste evaluation (Altuğ and Elmacı, 2011).

#### *Statistical Analysis*

Each trial was repeated twice and triplicate samples were tested at each sampling time. Data were subjected to variance analysis in order to determine the effect of gas composition and storage time on each variable. The analysis was performed using analysis of variance (ANOVA) one-way analysis, and statistical package (SPSS 15.0, USA) was used to identify the different groups. The Duncan's post hoc test was applied; significance level was p < 0.05. Control group samples were not included in statistical analysis owing to the earlier spoilage record on day 21<sup>st</sup>.

## **Results and Discussion**

#### *Physical and Chemical Analyses*

There was a decrease in the percentages of carbon dioxide during the cold storage owing to the absorption from the product itself and leakage from the package, while the values for control group samples' were increased to 0.3% on day 14<sup>th</sup> and finally to 4.6% on day 21<sup>st</sup> (Figure 1). Lactic acid bacteria and Gram (-) bacteria might produce carbon dioxide in headspace during the growth (Limbo et al., 2010). Earlier researches stated that headspace gas composition is not steady during storage owing to the microbial metabolism, gas solubility and film permeability (Jakobsen and Bertelsen, 2002; Simpson et al., 2009; Limbo et al., 2010). These findings are consistent with the result of present study.

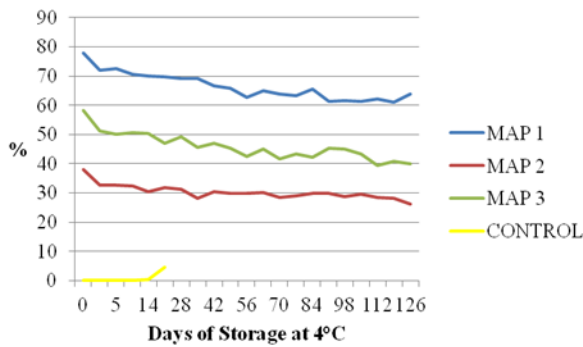


Figure 1. The changes in the percentages of carbon dioxide during storage (%). Legends to Figures: MAP 1 (80% CO<sub>2</sub> + 20% N<sub>2</sub>), MAP 2 (40% CO<sub>2</sub> + 60% N<sub>2</sub>), MAP 3 (60% CO<sub>2</sub> + 40% N<sub>2</sub>) and control (78% N<sub>2</sub> + 20.8% O<sub>2</sub>) treatments of modified atmosphere packaging (MAP).

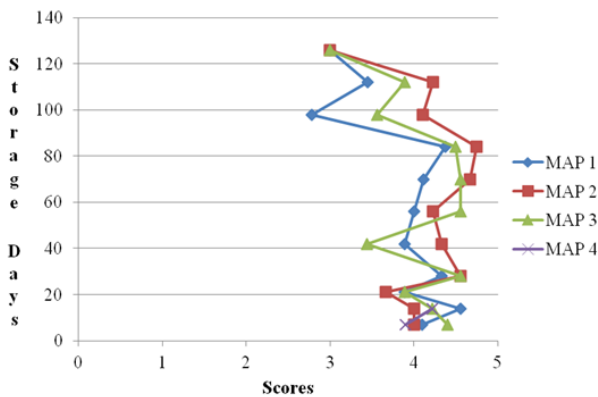


Figure 2 The changes of overall acceptability scores during storage in cooked manti samples. Legends to Figures: MAP 1 (80% CO<sub>2</sub> + 20% N<sub>2</sub>), MAP 2 (40% CO<sub>2</sub> + 60% N<sub>2</sub>), MAP 3 (60% CO<sub>2</sub> + 40% N<sub>2</sub>) and control (78% N<sub>2</sub> + 20.8% O<sub>2</sub>) treatments of modified atmosphere packaging (MAP).

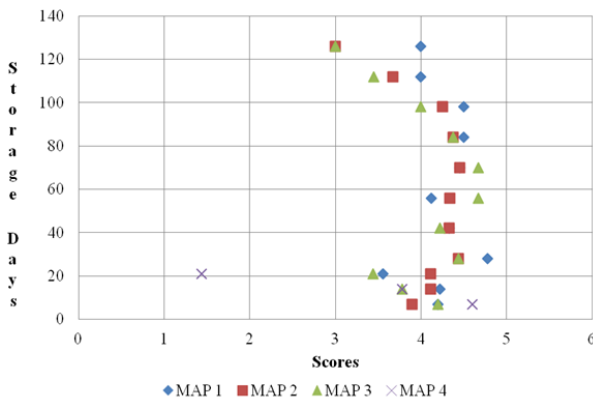


Figure 3 The changes of overall acceptability scores during storage in raw manti samples. Legends to Figures: MAP 1 (80% CO<sub>2</sub> + 20% N<sub>2</sub>), MAP 2 (40% CO<sub>2</sub> + 60% N<sub>2</sub>), MAP 3 (60% CO<sub>2</sub> + 40% N<sub>2</sub>) and control (78% N<sub>2</sub> + 20.8% O<sub>2</sub>) treatments of modified atmosphere packaging (MAP).

The levels of oxygen were found steady during the storage period (Figure 1), which was below 1.6%. The level of oxygen in control group samples' was decreased from 20.8% to 13.85% on day 21. It might be resulted from the growth of microorganisms (data not shown). Similar results were obtained at earlier researches, for bread (Degirmencioglu et al., 2011), and for beef (Ercolini et al., 2006).

Water activity (a<sub>w</sub>) values were found in the range of 0.876 and 0.904. There were no significant difference (P<0.05) during storage period and among the MAP conditions (data not shown). Spoilage related with mould in bakery products might be prevented by decreasing a<sub>w</sub> to 0.80 and using a 70% CO<sub>2</sub> in packaging (Giorni et al., 2008).

In the case of TBA values, there were no significant difference (P<0.05) among the samples during the storage period, until 98<sup>th</sup> day (Table 1). TBA values were higher in control samples than MAP packaged samples during the 21 day of storage (Table 1). It is well known that oxygen is the key element when forming TBA (Campo et al., 2006; Jongberg et al., 2011). Both using reduced oxygen and increased nitrogen levels in packaging are required to obtain lower TBA values (Berruga et al., 2005; Zakrys et al., 2008; Zakrys et al., 2009; Limbo et al., 2010; Zakrys-Waliwander et al., 2010). Literature values are consistent with the findings of current study. Using oxygen free MAP packages resulted in lower TBA values, because of the low lipid content of the meat. Lipid content of the samples remained at below 4% (data not shown), which is in the range of Turkish Standards quality index (Anonymous, 2003). A study reported that high lipid content of the meat might be one of the several reasons of high TBA value in manti samples (Yüçetepe, 2011). So, this implies the findings of current study.

The pH values of the samples were significantly (P<0.05) different on the last two storage days, which are 119<sup>th</sup> and 126<sup>th</sup> (data not shown). The biggest decrease was observed (from 6.52 to 6.04) on MAP 1 condition, which pertains to the higher carbon dioxide content. The others (MAP 2 and MAP 3) were slightly decreased (data not shown); the values for air packed samples were increased from 6.54 to 6.95 on day 21<sup>st</sup>. The finding for increased value of air packed sample was in accordance with a report (Argyri et al., 2011).

Dry matter of the samples were significantly (P<0.05) different among the MAP conditions on day 98<sup>th</sup>, 119<sup>th</sup>, and 126<sup>th</sup> days during the storage period (data not shown). There were slight decreases from the initial values at the end of the storage period.

Finally, the packaging materials were analysed for confirmation of delivery firm. The water vapour transmission rate of the tray was measured as 0.629 g/m<sup>2</sup>/day. The oxygen transmission rate of the film was found to be 16.5 ml/m<sup>2</sup>/day. It is stated that using films below 2 ml/m<sup>2</sup>/24 h oxygen permeability rate might extend shelf life of foods about 10-15% (Singh et al., 2011).

### Sensory Analyses

Scores for appearance, flavour, odour, texture and taste of cooked mantı samples showed similar trends in terms of decreasing sensorial quality up to a final day of 126. The variability in the results of a proximate analysis, such as lipid and pH of the samples, did not negatively affect sensory perception. Scores of raw mantı samples showed similar decreasing trend during refrigerated storage. It can be concluded that in terms of overall quality, MAP 2 samples were the most preferred for

cooked samples during the storage period (Figure 2) while the highest scores were obtained for MAP 1 raw samples (Figure 3).

In conclusion, MAP could extend the refrigerated storage of raw, fresh mantı up to six times compared to air packaging. The result of present study showed that the best preservation for raw fresh mantı was in MAP 1 (80% CO<sub>2</sub> + 20% N<sub>2</sub>) gas composition, which ensured acceptable sensory, physical and chemical analyses until the end of storage period of 126 days.

Table 1 The changes in TBA (thiobarbituric acid) values of packed mantı samples during storage at 4°C.

Storage days	MAP 1	MAP 2	MAP 3	MAP 4
7	0 <sup>ax</sup>	0.1092 <sup>bx</sup>	0.0858 <sup>bx</sup>	0.2574
14	0.1638 <sup>x</sup>	0.1248 <sup>x</sup>	0.1404 <sup>x</sup>	0.3042
21	0.2366 <sup>x</sup>	0.156 <sup>x</sup>	0.1872 <sup>x</sup>	0.3666
28	0.3016 <sup>abx</sup>	0.2106 <sup>abx</sup>	0.1456 <sup>bx</sup>	*
42	0.3224 <sup>ay</sup>	0.2548 <sup>by</sup>	0.3588 <sup>ay</sup>	*
56	0.3406 <sup>y</sup>	0.3564 <sup>y</sup>	0.4022 <sup>y</sup>	*
70	0.4235 <sup>y</sup>	0.4602 <sup>y</sup>	0.4472 <sup>y</sup>	*
84	0.351 <sup>ay</sup>	0.3354 <sup>ay</sup>	0.5772 <sup>by</sup>	*
98	0.195 <sup>az</sup>	0.2522 <sup>bz</sup>	0.2496 <sup>bz</sup>	*
112	0.5278 <sup>aq</sup>	0.39 <sup>bq</sup>	0.4945 <sup>aq</sup>	*
126	0.507 <sup>av</sup>	0.2886 <sup>bv</sup>	0.5304 <sup>av</sup>	*

\*Spoiled mantı sample. Data in the same column bearing different superscript letters (x,y,z,q,v) are significantly different (p<0,05). Data in the same row bearing different superscript letters (a,b,c) are significantly different (p<0,05). MAP 1 (80% CO<sub>2</sub> + 20% N<sub>2</sub>), MAP 2 (40% CO<sub>2</sub> + 60% N<sub>2</sub>), MAP 3 (60% CO<sub>2</sub> + 40% N<sub>2</sub>) and control (78% N<sub>2</sub> + 20.8% O<sub>2</sub>) treatments of modified atmosphere packaging (MAP)

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