USING INFRARED DRYING METHOD FOR PRODUCING PASTIRMA

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Abstract – Pastirma, an important cured meat product in Turkey, is manufactured as a result of a lengthy drying process. The aim of this study was to shorten the sweaty drying step which is the longest stage of pastirma processing by using infrared (IR) technique. Some physicochemical, microbiological and sensory quality of pastirma was investigated and compared to traditional open air (OA) and climate controlled (CC) drying procedures. Percent moisture, salt, protein, fat, water activity, pH, nitrite, TBA, color, texture profile analysis (TPA) and sensory parameters of the pastirma samples produced from two different muscles, loin and round, were investigated. In the results, using different meat muscles did not affect the above parameters tested. None of the samples contained *Salmonella spp.* while sulfite reducing anaerobic bacteria and coagulase positive *staphylococci* were below 10 CFU/g. The pastirma samples dried in CC were identified as the hardest in terms of TPA while the IR method was the best in terms of sensory properties. According to the findings of this study, with IR application, the drying processes was faster than the other methods, and quality was comparable to the other methods used in the research.

Key Words –Climate Controlled Drying, Loin, Open Air Drying, Round

I. INTRODUCTION

Pastirma is a salted, cured and dried meat product popular in Turkey and the Middle East. Its production involves a two step drying procedure of which the second stage is referred as "sweaty" drying stage. This stage takes about 7 days at 22 °C in open air which can be reduced to 5 days at 35-40 °C in climate controlled chambers. Using infrared (IR) energy has a potential to further reduce the duration of this particularly long drying stage.Therefore, the objective of this study was to evaluate the effect of open air, climate controlled chamber and IR drying techniques on some physicochemical and sensory properties of pastirma prepared using two different muscles from loin and round.

II. MATERIALS AND METHODS

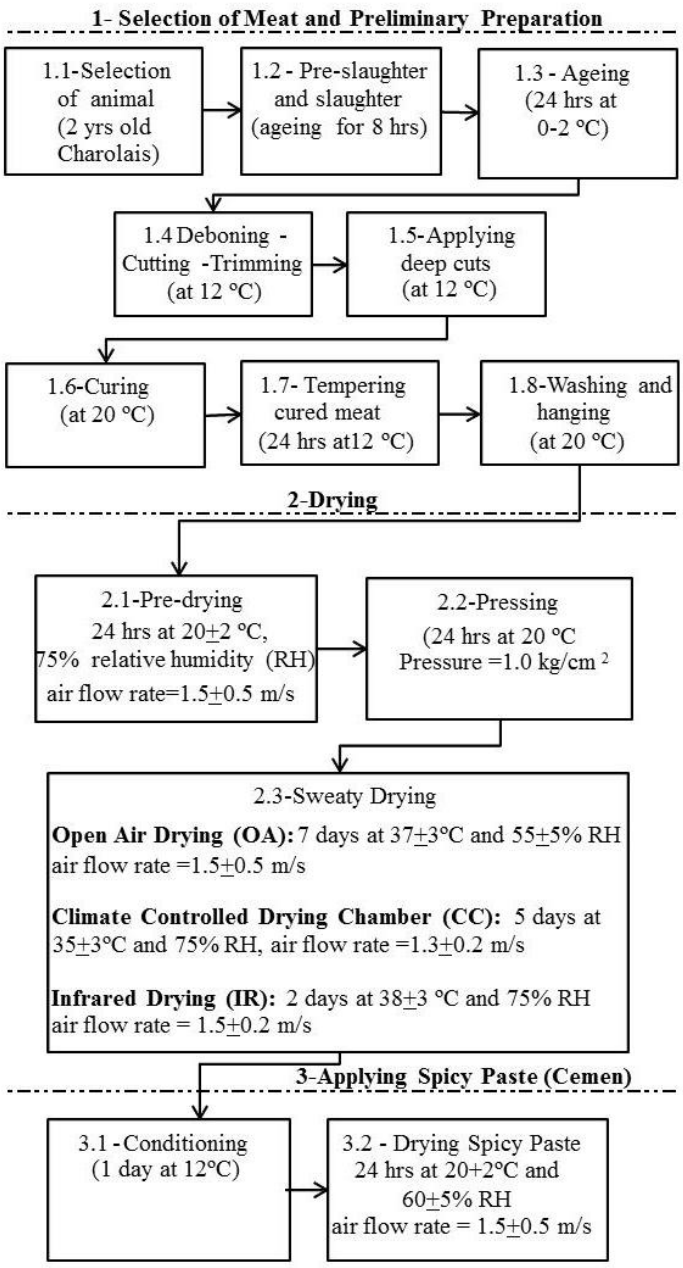
Beef was obtained from Saray Meat Processing Co., Kayseri, Turkey. Two different types of muscles from loin (*Longissimus dorsi*) and round (*Vastus* group) were used for pastirma production. Grain salt, sodium nitrite and sucrose were used as curing agent. The spicy paste referred as "cemen" to coat dried meat was prepared using fenugreek powder, chili powder and peeled garlic as described by Gokalp *et al.* [1].

Pastirma samples were manufactured as explained in Figure 1. The meat slabs were 25 cm in length and 10 cm in thickness. The infrared (IR) drying system was constructed by installing an IR bulb (250 W, 1100 nm wavelength) inside a stainless steel cabinet (40x50x34 cm^3). The cabinet contained a fan for air circulation and temperature was monitored using a temperature sensor. Open air (OA) drying, lasted for 7 days, was performed at 37+3 ºC and 55+5% relative humidity with an air flow rate of 1.5+0.5 m/s and shadowed to avoid direct sun light. Climate controlled (CC) drying was conducted in a chamber at 38+3 ºC and 75% relative humidity, with air circulation at a flow rate of 1.5+0.2 m/s.

Fresh meat used for pastirma production was tested for *Escherichia coli O157:H7* and *Staphyloccoccus aureus* according to TS EN ISO methods. Temperature and pH was measured using a pH meter (Testo 205, Germany). Moisture content of meat samples were measured using a moisture analyzer (Sartorious, MA30, Germany). Water activity was measured using a water activity meter (Aqua Lab 3TE, USA). Protein content was analyzed according to Dumas method (FP LECO, USA). Fat content was determined by solvent extraction.

Physicochemical analysis conducted on pastirma included pH (Hanna HI 2211, USA), moisture content (Sartorious, MA30, Germany), water

Figure 1. Flow chart of pastirma production [1]



activity (Aqua Lab 3TE, USA), fat content (Büchi B-811, Switzerland) and protein content (FP LECO, USA). Color was measured using a Minolta CR-300 (Osaka, Japan) colorimeter.

Residual nitrate content was determined using method described by Tauchman [2]. TBA test was conducted according to the method described by Ulu [3]. TPA analysis; hardness, stickiness, elasticity, coherence, gumminess, chewiness of pastirma was measured using a texture analyzer (Microstable TA.XT Plus, USA). Pastirma samples were analyzed for the presence of *Salmonella*, coagulase (+) *staphylococci* and sulfite reducing aerobic bacteria according to TS EN ISO methods. Sensory analysis was conducted by 10 trained panelists who evaluated pastirma for taste, color, appearance and texture. In the analyses, a 5 point scale was used for the descriptive test, 1 corresponding to reject and 5 to excellent. All panelists had extensive prior experience with pastirma.

Pastirma production was replicated twice while all physicochemical analyses were conducted in triplicate. Based on the results of General Linear Model test, one way ANOVAs with Tukey's post hoc test were performed to separate the means.

III. RESULTS AND DISCUSSION

In none of the fresh meat samples, *Escherichia coli O157:H7* and *Staphyloccoccus aureus* were determined. Some physicochemical properties of the fresh muscles from loin and round were given in Table 1. Only noticeable difference was with fat content of the muscles, 5.6% and 6.3% for loin and round, respectively.

Table 1. Physicochemical properties of fresh meat

Muscle type	pH	Moisture (%)	Water Activity	Fat (%)	Protein (%)
Loin	5.80	75	0.965	5.6	19.2
Round	5.90	77	0.998	6.3	21.3

Some physicochemical properties of pastirma were given in Table 2. As seen in the table, pH of pastirma samples ranged between 5.68-5.78. The samples produced by open air drying had significantly lower pH than the other samples ($p<0.05$). This might be due the fact that longer duration of open air (OA) drying allowed samples ferment more than other samples. Pastirma samples produced from loin had lower pH than the pastirma produced from round.

Moisture content of OA dried pastirma samples were significantly lower than pastirma dried using other drying methods for both muscle types

($p<0.05$). The lowest (35.69 %) moisture content was observed for OA dried loin pastirma while the highest moisture content observed for both muscle types was %42.61 of samples dried in the climate controlled (CC) chamber. The water activities of open air dried samples were significantly lower than the other samples. This might be related to the fact that OA dried samples also had the lowest moisture content (Table 2).

As seen in Table 2, the lowest ($p<0.05$) salt levels were observed for IR dried loin and round which was 7.82% and 8.25%, respectively. Other drying methods produced pastirma samples with significantly higher salt content. The fat content was affected by muscle type but not by the drying method. The pastirma samples produced from round had the highest fat content which might be related to the fact that fresh round also had higher fat level than fresh loin which were used to produce pastirma. The protein content was affected by the drying method but not by the muscle type. IR dried samples had significantly highest protein content while the open air dried samples had the lowest.

Table 2. Physicochemical properties of pastirma

Physicochemical properties	Muscle type	OA	CC	IR
pH	L	5.73^{bA}	5.78^{aA}	5.78^{aA}
	R	5.68^{bB}	5.72^{aB}	5.74^{aB}
Moisture (%)	L	35.69^{bA}	42.61^{aA}	41.17^{aA}
	R	37.57^{bA}	42.61^{aA}	39.00^{aA}
Wateractivity	L	0.842^{bA}	0.852^{aA}	0.867^{aA}
	R	0.846^{bA}	0.871^{aA}	0.867^{aA}
Salt (%)	L	9.08^{aA}	8.42^{aA}	7.82^{bA}
	R	8.67^{aA}	8.95^{aA}	8.25^{bA}
Fat (%)	L	5.38^{aB}	4.21^{aB}	4.14^{aB}
	R	7.06^{aA}	5.54^{aA}	8.07^{aA}
Protein (%)	L	36.88^{cA}	37.08^{bA}	38.70^{aA}
	R	36.50^{cA}	37.15^{bA}	38.70^{aA}
Nitrite (ppm)	L	18.76^{aA}	17.64^{bA}	17.67^{bA}
	R	18.75^{aA}	17.54^{bA}	17.34^{bA}
TBA (mg malondialdehyde/ kg)	L	0.29^{bA}	0.31^{aA}	0.07^{cA}
	R	0.16^{bA}	0.32^{aA}	0.13^{cA}

OA: open air drying, CC: climate controlled chamber drying, IR: infrared drying, L: loin, R: round, Means within the same row with different lowercase superscripts are significantly different ($p<0.05$) from each other. Means within the same column with different uppercase superscripts are significantly different ($p<0.05$) from each other.

Nitrite level was affected by drying method, OA dried samples had higher nitrite levels than the samples dried with other methods. TBA levels of CC chamber dried samples were the highest followed by OA dried pastirma samples. The lowest TBA values were observed with the IR dried samples. Among all the samples, IR dried pastirma may have had least oxygen exposure due to short sweaty drying phase. This might have made them less prone to oxidation; hence they had the lowest TBA values.

Color parameters were not significantly affected by the muscle type (Table 3). Open air dried samples were the darkest samples, while CC chamber dried samples were the lightest ($p<0.05$). a^* value of OA dried samples, which is an indication of redness, was lowest. Highest a^* values were observed for the CC chamber dried samples. Yellowness, b^* value, of OA dried samples were highest while CC chamber dried samples had lowest b^* values. For all color parameters, IR dried samples received medium scores between OA dried samples and CC chamber dried samples. Traditionally, a light pinkish red color is most desirable for pastirma. Therefore, it would be expected that darker red open air dried pastirma with more pronounced yellowness might not be very desirable [4].

Table 3. Color properties of pastirma

Color parameters	Muscle type	OA	CC	IR
L^*	L	25.02^{c}	32.88^{a}	30.15^{b}
	R	27.48^{c}	34.26^{a}	30.94^{b}
a^*	L	9.47^{c}	14.01^{a}	11.99^{b}
	R	10.40^{c}	15.45^{a}	13.30^{b}
b^*	L	4.49^{a}	1.73^{c}	2.51^{b}
	R	3.58^{a}	1.37^{c}	2.27^{b}

OA: open air drying, CC: climate controlled chamber drying, IR: infrared drying, L: loin, R: round, Means within the same row with different lowercase superscripts are significantly different ($p<0.05$) from each other.

Texture parameters were not significantly affected by the muscle type (Table 4). The lowest ($p<0.05$) hardness values were observed with OA dried pastirma samples. Climate controlled chamber dried and IR dried samples were similar in terms of hardness. Highest stickiness values were observed for OA dried pastirma samples. Climate controlled chamber dried and IR dried samples were similar in terms ofstickiness. However, IR dried pastirma samples were more elastic than the OA dried samples. Again OA dried samples were chewier than samples dried using other drying methods.

Table 4. Texture Profile Analysis of pastirma

Texture parameters	Muscle type	OA	CC	IR
Hardness (N)	L	16.33^{b}	32.21^{a}	25.53^{a}
	R	18.46^{b}	28.49^{a}	27.91^{a}
Stickiness	L	82.58^{a}	65.90^{b}	64.10^{b}
	R	84.84^{a}	67.39^{b}	64.79^{b}
Elasticity (mm)	L	1.52^{b}	1.68^{ab}	1.70^{a}
	R	1.64^{b}	1.61^{ab}	1.68^{a}
Coherence	L	0.57^{a}	0.62^{a}	0.64^{a}
	R	0.58^{a}	0.54^{a}	0.61^{a}
Gumminess (N)	L	27.66^{a}	24.41^{a}	24.92^{a}
	R	25.79^{a}	27.69^{a}	24.10^{a}
Chewiness (Nmm)	R	27.70^{a}	26.60^{b}	27.01^{b}
	L	30.52^{a}	25.99^{b}	26.26^{b}

OA: open air drying, CC: climate controlled chamber drying, ID: infrared drying, L: loin, R: round, Means within the same row with different lowercase superscripts are significantly different ($p<0.05$) from each other.

Sensory parameters of pastirma samples were not significantly affected by the muscle type (Table 5). IR dried pastirma samples received the highest sensory scores for all parameters. They had significantly ($p<0.05$) better taste, color, appearance and texture than the all other samples. Sensory scores were low in general which was probably an indication of the high quality standards of the trained panel.

In the microbiological analysis of pastirma, *Salmonella* was not identified in any of the samples. Both coagulase (+) *staphylococci* and sulfite reducing aerobic bacteria were less than 10 CFU/g.

Table 5. Sensory properties of pastirma

Sensory properties	Muscle type	OA	CC	IR
Taste	R	2.20^{b}	2.20^{b}	3.10^{a}
	L	2.00^{b}	2.00^{b}	3.30^{a}
Color	R	2.20^{b}	2.60^{b}	3.40^{a}
	L	2.60^{b}	2.80^{b}	3.40^{a}
Appearance	R	2.30^{b}	2.20^{b}	2.90^{a}
	L	2.10^{b}	2.40^{b}	2.80^{a}
Texture	R	2.10^{c}	2.40^{b}	2.70^{a}
	L	2.00^{c}	2.20^{b}	3.50^{a}

OA: open air drying, CC: climate controlled chamber drying, IR: infrared drying, L: loin, R: round, Means within the same row with different lowercase superscripts are significantly different ($p<0.05$) from each other.

IV. CONCLUSION

This study clearly showed that IR drying has a potential to reduce sweaty drying phase of pastirma processing from 7 to 2 days without compromising the quality. As a matter of fact, IR dried samples were rated favorably over the other samples in terms of all sensory parameters including taste, color, appearance and texture. It might be suggested that IR drying technique can be optimized in order to further reduce drying time of meats without compromising the quality.

V. REFERENCES

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