

EFFECTS OF ENCAPSULATED SODIUM TRIPOLYPHOSPHATE, SODIUM ACID PYROPHOSPHATE AND SODIUM HEXAMETAPHOSPHATE ON SHELF LIFE AND QUALITY CHARACTERISTICS OF READY TO EAT GROUND BEEF DONER KEBAB

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Abstract – The objective of this study was to determine effect of polyphosphate (PP) types (Sodium tripolyphosphate, STP; sodium hexametaphosphate, HMP; sodium pyrophosphate, SPP) and the ratio of encapsulated (e) PP at 0.5% added total PP on shelf life and quality characteristics of ground beef döner kebab. Results indicated that the use of STP resulted in lower cooking loss (CL) compared to HMP or SPP ($p<0.05$). pH of döner kebabs containing STP were higher than the pH of those containing SPP ($p<0.05$). The ratio of ePP at 0.5% added total PP (T) had no effect on CL and pH. The highest soluble orthophosphate (OP) was obtained with STP, followed by SPP, HMP and control ($p<0.05$). The level of OP increased in all döner kebab treatment groups during storage. Thiobarbituric acid reactive substances (TBARS) and lipid hydroperoxides (LPO) values of all döner kebabs containing PP were lower than that of the control ($p<0.05$). As far as PP types were concerned, the lowest TBARS and LPO were determined in döner kebab samples containing STP or SPP ($p<0.05$). It was determined that OP, TBARS and LPO values decreased with increasing T ($p<0.05$).

Key Words – Encapsulated polyphosphate, shelf life, döner kebab, quality.

I. INTRODUCTION

Döner kebab is a traditional Turkish meat product which is known by different names such as döner kebabs, törki kebab, shawirma, gyros and donair [1]. Döner kebab is one of the most popular fast-food dishes in the world. Döner kebab is sold as raw or ready to eat (RTE) product in the market. Lipid oxidation is one of a major problem in the storage of döner kebab. Lipid oxidation is an

important problem in RTE meat products and it limits the shelf life of the product [2, 3]. Lipid oxidation also causes quality problems such as discoloration, drip losses, off-flavor and off-odor developments [4]. As a result of lipid oxidation of meat, reliability is also jeopardized due to the induced formation of carcinogenic and mutagenic substances [5, 6]. PP have very strong antioxidant effects in cooked meat products by binding metal ions. However, the ability to inhibit lipid oxidation by added PP in cooked meat products is reduced by phosphatases [7]. Even though phosphatase activity is greatly reduced by cooking, most of the added PP are lost by the time meat is cooked due to phosphatase activity in meat [8]. It was proven that encapsulation technology can be applied to PP to protect them from phosphatases in order to accomplish more effective lipid oxidation inhibition in muscle foods [9]. The purpose of present study was to determine optimum PP type and the ratio of ePP at 0.5% added total PP to enhance the shelf life and quality characteristics of ground beef döner kebab during storage.

II. MATERIALS AND METHODS

Beef (*Musculus longissimus dorsi*) and beef tallow were purchased from a local slaughterhouse (Isparta, Turkey). Spices and yogurt were provided by Arifoglu Spices and Food Industry (Istanbul, Turkey) and Pınar A.Ş (Izmir, Turkey), respectively. The three PP used (STP: Brifisol 5-1327; HMP: 7-1462; SPP: 5-1230) were obtained from a commercial supplier (BK Giulini Corporation, Simi Valley, CA, U.S.A.). Encapsulation was accomplished by a commercial

coating company (Coating Place Inc., Verona, WI, U.S.A) as described by Kılıç et al. [10].

Raw meat was ground (9.5 mm) and then 10% added ground beef fat (meat weight basis), mixed in a bowl mixer and then reground (3.2 mm). All treatments contained 2.0% sodium chloride, 10% added distilled water, 1% yogurt, 0.25% black pepper, white pepper and onion powder with 0.125% cumin and allspice (meat weight basis). After the first grind and initial mixing the test ingredients were incorporated using a hand mixer. Döner batter was formulated with various amounts of ePP (0.1, 0.2, 0.3, 0.4, 0.5%) that was combined with unencapsulated(u) counterparts to contain 0.5% total added PP (PP weight basis; Table 1).

Table 1. Coding for PP treatments evaluated.

PP treatment	ePP and uPP level (%)
STP0	0.5% uSTP
STP0.1	0.4% uSTP + 0.1% eSTP
STP0.2	0.3% uSTP + 0.2% eSTP
STP0.3	0.2% uSTP + 0.3% eSTP
STP0.4	0.1% uSTP + 0.4% eSTP
STP0.5	0.5% eSTP
HMP0	0.5% uHMP
HMP0.1	0.4% uHMP + 0.1% eHMP
HMP0.2	0.3% uHMP + 0.2% eHMP
HMP0.3	0.2% uHMP + 0.3% eHMP
HMP0.4	0.1% uHMP + 0.4% eHMP
HMP0.5	0.5% eHMP
SPP0	0.5% uSPP
SPP0.1	0.4% uSPP + 0.1% eSPP
SPP0.2	0.3% uSPP + 0.2% eSPP
SPP0.3	0.2% uSPP + 0.3% eSPP
SPP0.4	0.1% uSPP + 0.4% eSPP
SPP0.5	0.5% eSPP

STP: Sodium tripolyphosphate, HMP: Sodium hexametaphosphate, SPP: Sodium acid pyrophosphate, u: unencapsulated, e: encapsulated.

Döner batter was wrapped tightly with stretch film and stored at 4 °C for 6 h. Then the döner batter was placed on döner kebab sticks and each side of the döner kebab meat block was cooked for 4 min. After 4 min cooking, the döner block was rotated and while the cooked surface was cut into 5 mm thickness, the other side was cooked for 4 min. This procedure was repeated continuously until the whole döner block was cooked. Following cooking and slicing, samples were cooled at room temperature for 20 min to reach 18-20°C and döner kebab weight was recorded to calculate CL. CL [10], protein, fat, ash, moisture [11], texture

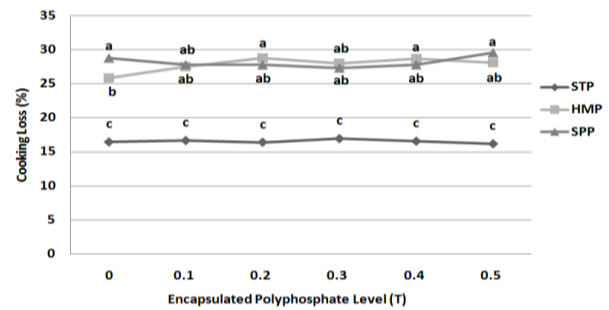
and fatty acid composition analysis [12] were taken at the same day of manufacturing. Other samples were vacuum packaged and stored for 60 days at 4 °C. pH, TBARS, LPO, OP and color were also determined at certain intervals during storage as described by Kılıç et al. [10]. The experimental design for statistical purposes was three PP types x six combinations of ePP and uPP x seven storage times as a factorial arrangement.

III. RESULTS AND DISCUSSION

Cooking Loss

The changes in CL of döner kebab samples are shown in Figure 1.

Figure 1. The effect of the ratio of ePP in the total amount of added PP on CL.



Regardless of T, the higher ($p < 0.05$) CL was observed in the samples with SPP or HMP compared to the samples with STP. This might be due to improve the water holding capacity of the muscle proteins at increased pH by STP. The use of STP resulted in lower CL than the control ($p < 0.05$) that had similar CL with the samples with HMP or SPP. Regardless of PP type, T was not a significant factor for CL changes.

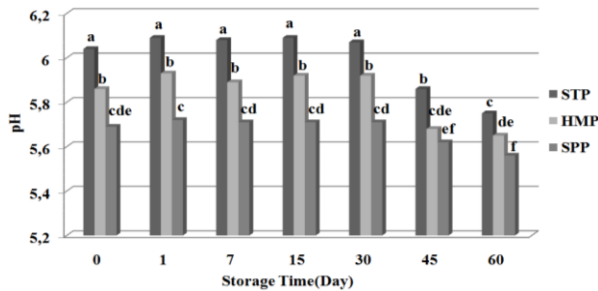
Color, pH, moisture, protein, fat, ash and fatty acid profile

The highest L^* values were determined in döner kebabs with HMP or SPP, and the lowest L^* values were determined in the samples with STP ($p < 0.05$). The highest a^* values were obtained in the samples with STP, and the lowest a^* values were obtained with the use of SPP ($p < 0.05$). The lower a^* values were determined in döner kebabs with 0.5% ePP than those with 0.5% uPP ($p < 0.05$).

a* values decreased during the storage ($p < 0.05$). The use of STP resulted in lower b* compared to that of HMP or SPP ($p < 0.05$). T was not a factor affecting L* and b* values.

pH values of döner kebabs with STP were higher than the pH of the samples with SPP ($p < 0.05$). The samples with HMP had pH falling between döner kebabs with STP or SPP ($p < 0.05$). T had no significant effect on pH. There was no important pH change in all treatment groups during 30 d storage, a significant pH decrease was determined on day 45 and 60 ($p < 0.05$; Fig. 2).

Figure 2. The effect of PP type on pH during storage.



Protein values of döner kebabs with SPP were lower than that of those with HMP or STP ($p < 0.05$). Döner kebabs with SPP had lower fat than those with HMP or SPP ($p < 0.05$). The highest moisture levels were determined in the samples with STP and the lowest values were obtained in the samples with SPP ($p < 0.05$). Even though the lowest ash was found in control ($p < 0.05$), there was no significant differences among all other samples with PP. T did not have a significant effect on the amount of moisture, protein, fat and ash (Data is not presented). The results revealed that encapsulation and the ratio of eSTP in total amount of added STP had no effect on fatty acid composition of döner kebabs compared to döner kebabs with 0.5% uSTP (Data is not presented).

Texture Profile Analysis

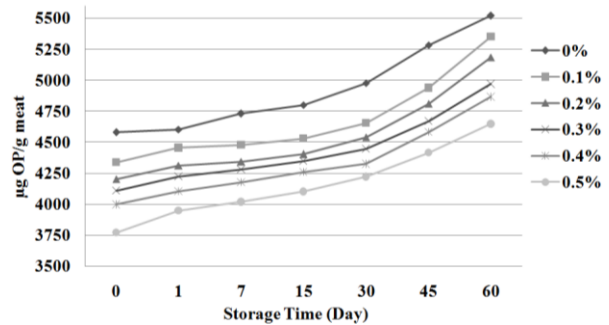
The results (Data is not presented) showed that STP increased and SPP decreased cohesiveness, resilience, springiness values of döner kebabs ($p < 0.05$). The use of STP or SPP resulted in an increase in hardness compared to HMP ($p < 0.05$). Adhesiveness, gumminess and chewiness were not

affected by PP type. Furthermore, T had no significant effect on the textural properties.

Soluble Orthophosphates (OP)

OP content of all döner kebabs generally increased ($p < 0.05$) during 60 d storage (Fig. 3). Regardless of T, the higher ($p < 0.05$) OP was determined with using STP compared to SPP or HMP. The lowest OP was obtained in the control ($p < 0.05$). OP decreased ($p < 0.05$) with increasing T. This result was anticipated as a higher T would serve as less substrate for hydrolysis by undenatured phosphatases.

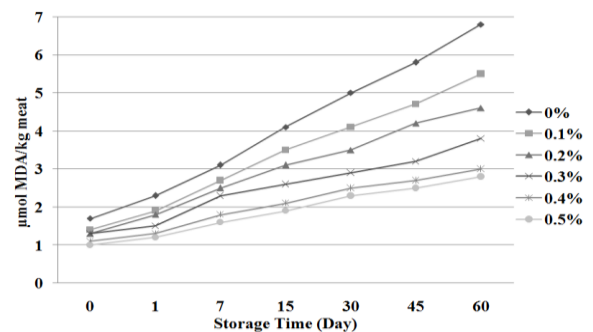
Figure 3. The effect of the ratio of ePP in the total amount of added PP on OP.



TBARS

The TBARS values increased gradually during storage (Fig. 4) in all döner kebabs ($p < 0.05$). Regardless of T, the lowest ($p < 0.05$) TBARS were determined in the samples with SPP followed by STP. The highest ($p < 0.05$) TBARS were obtained in samples with HMP.

Figure 4. The effect of the ratio of ePP in the total amount of added PP on TBARS.

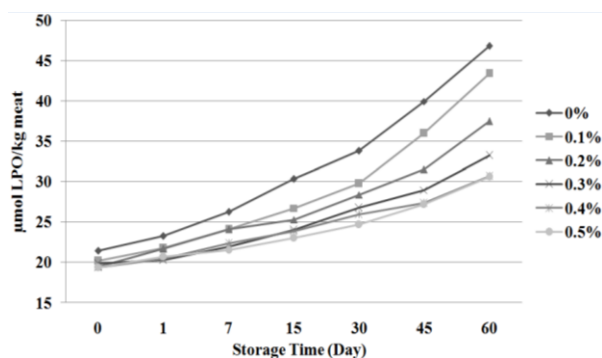


Furthermore, increasing T resulted in lower ($p < 0.05$) TBARS. This was probably because that increasing T provide an increase in the amount of active PP, leading to have more effective lipid oxidation inhibition.

Lipid Hydroperoxides(LPO)

There was a gradual increase in LPO (Fig. 5) in all döner kebabs during 60 days storage ($p < 0.05$). Regardless of T, the lower LPO were obtained with SPP or STP compared to HMP. The highest LPO was obtained in the control. Increasing T upto 0.3% caused a decrease ($p < 0.05$) in LPO of döner kebabs while increasing T from 0.3% to 0.5% did not create any significant differences in LPO.

Figure 5. The effect of the ratio of ePP in the total amount of added PP on LPO.



IV. CONCLUSION

This study showed that better oxidation inhibition in döner kebabs during storage can be obtained by SPP or STP compared to HMP. Antioxidant effect of all PP type can be enhanced with increasing T in döner kebab formulation. Furthermore, the results indicated that OP decreased with increasing T while increasing T had no effect on CL, pH, textural properties, fatty acid composition and chemical composition. Study results suggested that increasing T upto 0.2% for SPP, upto 0.3% for STP and upto 0.5% for HMP can be used by meat manufacturers to prolong shelf life of RTE döner kebab.

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