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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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The Effect of Liquid Smoke Utilization as Preservative for Meatballs Quality

Arnim[1], Ferawati[1] and Yetti Marlida[2]
[1]Department of Animal Production, Faculty of Animal Sciences, Andalas University, Indonesia
[2]Department of Animal Nutrition, Faculty of Animal Sciences, Andalas University, Indonesia

Abstract: The aim of this research was to test the effectiveness of coconut shell liquid smoke in preservation of meatballs. The research had been performed using factorial Completely Randomized Design (CRD) with two factors i.e. liquid smoke concentration (0%, 3%, 5% and 7%) and shelf life at refrigeration temperature (0, 5, 10 and 15 days). Parameter analyzed were water content, protein content, fat content, pH and Total Plate Count (TPC). Liquid smoke concentration had significant effect on water content, protein content, fat content, pH and Total Plate Count. Shelf life had significant effect on water content, protein content, fat content and Total Plate Count but not for pH. The interaction of liquid smoke concentration and shelf life had significant effect on protein content only. Applications of 7% liquid smoke in meatballs at 4±1°C increased shelf life until 15 days storage were better accepted and retarded the decreased of pH and moisture content compared to control. The result indicated that liquid smoke was an effective preservative agent for meatballs.

Key words: Coconut shell liquid smoke, meatballs preservation, TPC value

INTRODUCTION

Raw meat ball is a traditional raw meat product which is consumed particularly in Indonesia. Although raw meat ball is produced widely there are no standards established in terms of production methods and technology, food additives and their quantities, ingredients and microbiological quality. Methods that are used during production and ingredients vary depend on the location. Traditional raw meat ball is made with naked hands. It requires to be mixed up all the ingredients and to be prepared like a dough by the movements of smashing until required texture is obtained. The microbiological quality of the raw meat and other ingredients, personal hygiene and any contamination during the process will determine the microbiological quality of end product. Ingredients used in the processing of food products are among the most important factors having great influence on the final quality. Smoking of meat product is a well known preservation technique and has been shown to inhibit the growth of microbial. Several experiments have also documented the antimicrobial effects of liquid smoke additives.

Liquid smoke compositions are obtained from pyrolysis of hardwood such as coconut shell. These solutions are used to provide enhanced shelf life for food products. The constituents of liquid smoke are obtained from thermal degradation reaction of cellulose, hemicellulose and lignin. More than four hundred compounds have been detected in wood smoke. In order to express the composition from an application stand point, the compounds in liquid smoke have been lumped together as three functional groups: carboxylic acids, phenols and carbonyl. Cellulose and hemicellulose degradation are the primary sources of carbonyl and carboxylic acids, while phenols are obtained from lignin pyrolysis. In addition to these functional classes, there are other products like alcohols, lactones and hydrocarbons. Liquid smoke is one of the oldest methods of food preservation. Using that specific method, the food is simultaneously subjected to a heat and chemicals, present in the smoke obtained by wood combustion (Toth and Potthast, 1984; Gullien and Manzanos, 1996). Smoke is an antimicrobial and antioxidant agent. Studies done on the effect of liquid smoke utilization as preservative for meatballs quality.

MATERIALS AND METHODS

Samples: Thirty two samples (about 1920 g) of meat ball that mixed liquid smoke concentration (0%, 3%, 5% and 7%). Samples was stored at ±4°C for 0, 5, 10 and 15 days.

Analysis: To analyze the samples of meat balls, the methods stated in Association of Official Analytical Chemist (AOAC, 1995) and Laboratory Excercises in Microbiology (Harley and Prescott, 1993). Plate Count Agar (PCA) medium was used to determine the total bacteria number. Colony counting was carried out after the 48-hrs incubation at 37°C set, by speed plate method.

Statistical analysis: Least Significant Difference (LSD) was used to analyze the results statistically.

Corresponding Author: Yetti Marlida, Department of Animal Nutrition, Faculty of Animal Sciences, Andalas University, Indonesia

Table 1: Water content of meatballs after added with liquid smoke in different concentration

Duration storage (days)	Liquid smoke concentration (%) 0	3	5	7	Average
0	75.90	75.35	74.46	74.74	75.11[a]
5	70.41	71.40	70.67	69.41	71.24[b]
10	69.41	69.13	68.48	67.30	68.58[b]
15	69.28	68.61	68.07	65.96	67.98[b]
Average	71.72[a]	71.18[ab]	70.49[ab]	69.52[b]	

Mean with the same letter are not significantly different ($p<0.05$)

Table 2: Protein content of meatballs after added with liquid smoke in different concentration

Duration storage (days)	Liquid smoke concentration (%) 0	3	5	7	Average
0	17.59[Aa]	17.95[Aa]	18.49[Aa]	18.48[Aa]	18.12
5	17.24[Aab]	17.89[Aab]	18.16[Aab]	18.27[Aa]	17.89
10	15.81[Ac]	16.71[ABab]	16.93[ABbc]	17.97[Ba]	16.85
15	13.88[Ad]	15.18[ABc]	16.22[BCc]	17.50[Ca]	15.69
Average	16.13	16.93	17.45	18.05	

Mean with the same letter(s) within the same column are not significantly different ($p<0.05$)

RESULTS AND DISCUSSION

Effect of liquid smoke of water content of meatballs: Water content of meatballs after treated with liquid smoke can be showed in Table 1. Table 1 showed that the water content of meatballs during storage at 4°C. At day 0 until 15, for all concentration of liquid smoke was observed whereas the water content have reduced. This change could be related to acetic acid on liquid smoke component. The meatballs ion H^+ was bound with acetic acid, it caused reducing of meatballs water content. Another situation that determine are cold evaporation of water content at low temperature (Hadiwiyoto, 1993).

Effect of liquid smoke of protein content of meatballs: Table 2 shows the protein content of meatballs during storage at 4°C. The interaction available among the duration storage than liquid smoke concentration. At day 10 and 15, for all liquid smoke concentration and duration storage was observed the protein content was changing. The increasing of protein content was explained that reducing the meatballs total solid. Another factor that determine to this condition are liquid smoke antimicrobial agent. Because, the changes in food quality caused by microbiological activity make it useless for the people consumption. It is important to work out such technological procedures that eliminate or limit the rate of microorganisms propagation in food products and extend their storage life (Kowalski and Prycz, 2003; Toth and Potthast, 1984). Because refrigeration temperatures alone will inhibit the growth of proteolytic strains.

Any psychrotrophs bacterial can grow at refrigeration temperatures. Nevertheless, the liquid smoke effects observed as a decrease in number of microorganisms, or a suppression of their development consists in microbiocytic or microbiostatic activity of numerous smoke components. Soldera *et al*. (2008) investigated this strongest antibacterial effect gives formaldehyde, while anti-mold effect-phenol, guaiac resins and their derivatives.

Table 3: Fat content of meatballs after added with liquid smoke in different concentration

Duration storage (days)	Liquid smoke concentration (%) 0	3	5	7	Average
0	1.06	0.97	1.01	1.16	1.05[a]
5	0.83	0.94	1.06	1.17	1.00[ab]
10	0.74	0.76	1.00	1.01	0.88[ab]
15	0.69	0.80	0.89	1.06	0.86[b]
Average	0.83[a]	0.87[ab]	0.99[ab]	1.10[b]	

Mean with the same letter are not significantly different ($p<0.05$)

Effect of liquid smoke of fat content of meatballs: Table 3 shows the fat content of meatballs during storage at 4°C. At 0, 3, 5 and 7% concentration of liquid smoke was observed whereas the fat content was increased. The increasing of fat content was explained that reducing the meatballs total solid. Davidson *et al*. (2005) investigated that liquid smoked products are more resistant to the rancid process. Anti-oxidizing properties of the smoke are attributed more to the components dispersed than to the dispersing phase. Phenols, less carboxylic acids, are characterized as strong antioxidants. Among the phenol group, the strongest antioxidants are 3-methylpyrocatechol and pyrogallol, then, in decreasing rate: Hydroquinone and its homologous, guaiac resins and their homologous, mono-hydroxyl phenols. Antioxidizing properties display also formic acid, benzoate acid, salicylic acid, vanilla. The anti-oxidizing properties of smoke retards auto-oxidation of fats. Characteristic for the microorganisms is different susceptibility to the smoke effect.

Effect of liquid smoke of pH value of meatballs: Table 4 shows the pH values were significantly lower for high concentration of liquid smoke meatballs ($p>0.05$) during storage at 4°C. At 0 to 7% liquid smoke concentration for all day was observed whereas the value was sharply decreased. However, we did not observe any changes in 3 and 5% liquid smoke concentration. The change could be related by acetic acid in liquid smoke component. Acetic acid has been identified as the most prevalent organic acid present in smoke, followed by formic, propionic, butyric and other acids (Wahyuningsih, 2006).

Effect of liquid smoke of Total Plate Count (TPC) of meatballs: Table 5 shows the TPC were significantly lower for high concentration of liquid smoke meatballs ($p>0.05$) during storage at 4°C. At 0 to 7% liquid smoke concentration for all day was observed whereas the value was sharply decreased. However, we did not

Table 4: pH value of meatballs after added with liquid smoke in different concentration

Duration storage (days)	Liquid smoke concentration (%) 0	3	5	7	Average
0	6.24	5.71	5.65	5.47	5.77
5	6.20	5.72	5.65	5.48	5.76
10	6.27	5.74	5.69	5.47	5.79
15	6.33	5.78	5.71	5.48	5.83
Average	6.26[a]	5.74[b]	5.67[b]	5.47[c]	

Mean with the same letter are not significantly different ($p<0.05$)

Table 5: Total Plate Count (TPC) log CFU/gram after added with liquid smoke in different concentration

Duration storage (days)	Liquid smoke concentration (%) 0	3	5	7	Average
0	3.0777	2.8451	2.7386	1.2386	2.4750[a]
5	4.7186	4.5573	4.3601	3.9226	4.3896[b]
10	5.9912	5.3630	5.0396	4.5881	5.2455[b]
15	6.1335	5.8163	5.2386	4.8407	5.5073[b]
Average	4.9802[a]	4.6454[ab]	4.3442[ab]	3.6475[b]	

Mean with the same letter are not significantly different ($p<0.05$)

observe any changes in 3, 5 and 7%. The change could be related by liquid smoke component as antimicrobial agent are carboxylic acids, phenols and carbonyl. Phenolic and acid compounds are responsible for inhibiting growth microbiological in meat product (Kjallstrand and Petersson, 2001). Liquid smoke are known to have a bacteriostatic effect (Faith *et al*., 1992; Sunen, 1998). Liquid smoke probably acts on the cell membrane and directly or indirectly on the stability of bacteria. This change also could be related to low temperature adaptation.

Conclusion: Applications of 7% liquid smoke in meatballs at 4±1°C increased shelf life until 15 days storage were better accepted and retarded the decreased of pH and moisture content compared to control. The result indicated that liquid smoke was an effective preservative agent for meatballs.

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