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Original Research Article

The Influence of *Angkak* Treatment on Physical, Chemical and Organoleptical Characteristics of the Castoff Duck Meat Sausage

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Abstract: This research is aimed to understand the influence of *angkak* as curing material and natural color maker on physical and chemical characteristics and also on organoleptical test of castoff duck meat sausage, in effort to maintain the quality of castoff duck meat sausage. Data were analyzed with analysis of variance using Complete Random Planning 4x4. Treatment involves various *angkak* levels, such as 0% (without treatment), 1%, 1.5%, and 2%. It includes 4 times replications continued with HSD Test. Organoleptical test is done by the panelist using *Scoring for Intensity Test* on color, flavor, taste and texture tests. Results of physical test (color, water holding capacity and pH), chemical test (water content, lipid and protein) and bacterial total showing that angkak treatment at levels of 0%,1%, 1.5%, and 2%, may give obvious influence ($P < 0.05$) on duck meat sausage. Color organoleptical test is giving very obvious influence ($P < 0.01$), whereas organoleptical tests of aroma, taste and texture do not give obvious influence ($P > 0.01$). Result of research indicates that *angkak* treatment 1% is already effective to maintain sausage quality and useful as curing compound and natural color maker n the preparation of castoff duck meat sausage.
Keywords: Sausage, Curing, *Angkak*, Castoff Duck, Color, Organoleptic.

INTRODUCTION

Duck meat consumed by people originates from the castoff meat of the male and female egg-layering ducks. The quality of this meat is usually relatively low with taste and texture of harsh and clay, and also giving off-odor [1]. Off-odor from the castoff duck meat is the result of lipid oxidation because it contains high level of unsaturated lipid acid. Improving meat texture and reducing off-odor can be done by diversification of duck meat processing. One of the diversified processed products to increase taste and to improve the texture is sausage.

One method for sausage preparation is curing process. This process is aimed to obtain the stability of color, aroma and texture, to acquire good taste, and to elongate product storage. Curing materials such as salt (sodium chloride) (NaCl), sodium nitrite, sodium nitrate, and sugar, are functioned to prevent meat quality during the processing and to give attractive appeal for the processed products. The function of nitrite can be the precursor of carcinogenic process because it will react with amine in protein components such that it establishes nitrosamine [2]. One material that can used to replace nitrite functions as preservative, taste provider, texture builder or less-dangerous natural color maker, is *angkak*.

Angkak is made of rice fermented using *Monascus purpureus* fungus such that the appearance is red in color. *Angkak* has been known widely as the natural color maker at food grade, and is usually used on fish, Chinese cheese, red wine and sausage [3]. Being natural color maker, *angkak* is also useful for taste provider, preservative, texture builder and medicine because it contains efficacious bioactive material. *Monascus purpureus* fungus also produces less toxic pigments which do not disturb body thickness system. The use of *angkak* can reduce the use of nitrite into food materials. Through its characteristic as anti-bacterial, the use of *angkak* in sausage preparation is important as the producer of red color and also as the safe preservative for heath. Other advantages of *angkak* in sausage preparation are that it improves texture and flavor. The coloration using pigments produced by *Monascus purpureus* is very stable and may not change the taste of nata de coco [4]. This flour is very safe because it gives no negative impact on health, easily produced, relatively cheaper and affordable. The use of *angkak* at optimum level in meat product is attaining 1.6 % (w/w) [5]. This research attempts to review the

potentials of *angkak* as binder compound, texture improver, natural color maker, and preservative in the preparation of castoff duck meat sausage.

MATERIALS AND METHODS

Sausage preparation procedure

Material used for sausage preparation is castoff local duck meat. Local duck selected is aged at 20-24 months old, which is then peeled, washed and cut into 4 pieces at 2x2 cm size. The meat is cured by giving treatment with 2% salt, 1.67% sugar and various levels of *angkak* flour (0%, 1%, 1.5% and 2%). Treated meat is incubated for 24 hours at 5°C. It is grounded and added with flavor formula combination [6,7]; including 1.5% white onion, 0.5% spice, 0.75% ginger, 0.5% nutmeg, which all of them are in flour, and also 15% vegetable oil, 5.7% tapioca flour, 3.5% skim milk, 16.7% ice cube, and 0.3 % STTP. The batter is bended and poured into the shell at 10 cm length and 2.5 cm diameter. It is cooked through steaming at 85°C for 30 minutes.

Data Analysis

Data obtained from all observation variables are analyzed using the design of Complete Random Planning. The design involves 4 replications. If there is obvious influence, the data are analyzed with Honest Obvious Differential Test (HSD). The tested variables include Texture, Color (L, a, b), Water Holding Capacity, pH, Water Content, Protein, Lipid and Bacterial Total. Organoleptical test uses *Scoring for Intensity Test* [8].

RESULTS AND DISCUSSION

Physical Characteristic of Meat Sausage

The description of mean (average rate) and deviation standard in four treatments is as follows: R_0 = without *angkak* concentration; R_1 = *angkak* treatment at 1% concentration; R_2 = *angkak* treatment at 1.5% concentration; and R_3 = *angkak* treatment at 2% concentration. The explanation is given in Table 1.

The means of texture, color (L, a, b), and water holding capacity are ordered as follows: 5.93-9.03, (39.90 – 48.48; 15.53 – 28.60; 15.58 – 17.78); and 45.97% – 47.18%. Water content, protein content, pH and lipid rate are ordered as follows: 63.90% – 65.53%; 12.03% –14.44%; 5.90% – 6.30%; and 7.31% – 7.89%. Bacterial Total is ranging from 6.32 – 6.86 log (cfu/g).

Result of texture observation has found obvious difference ($p < 0.05$). The higher concentration of *angkak* treatment is the better texture of castoff duck meat sausage. It is possible because enzymes in *angkak*, one of them is protease, can increase protein content. It is consistent to previous study which found that fungus in *angkak* can produce enzymes such as α-amylase, β-amylase, glucoamylase, lipase, protease, glucosidase, and ribonuclease [5]. Therefore, greater *angkak* concentration will produce greater protein content. Protein has the ability to bind lipid and water, such that the obtained sausage emulsion will be stable with more solid texture [9].

Table-1: The Mean of Physical Characteristic of Duck Meat Sausage

Parameters	*Angkak* Concentration			
	0%	1%	1.5%	2%
Texture	5.93 ± 0.22^{a}	7.70 ± 0.08^{b}	7.80 ± 0.08^{b}	9.03 ± 0.09^{c}
Color (L)	48.48 ± 0.10^{d}	43.85 ± 0.06^{c}	42.20 ± 0.12^{b}	$39.30^{d} \pm 12^{a}$
Color (a)	15.53 ± 0.21^{a}	23.43 ± 0.13^{b}	26.13 ± 0.15^{c}	28.60 ± 0.12^{d}
Color (b)	17.78 ± 0.05^{d}	16.6 ± 0.05^{c}	16.25 ± 0.05^{b}	15.58 ± 0.05^{a}
WHC	45.97 ± 0.01^{a}	46.35 ± 0.01^{b}	46.67 ± 0.01^{c}	47.18 ± 0.01^{d}
pH rate	6.3 ± 0.05^{c}	6.2 ± 0.05^{bc}	6.1 ± 0.05^{b}	5.9 ± 0.05^{a}

Note: Different notation shows different treatment ($p < 0.05$)

The level of color (L) in this research is ranged from 39.30 to 48.8, meaning that brightness rate of sausage color is dark or reddish. Color (L) brightness declines after *angkak* treatment, whereas color (a) brightness increases after *angkak* treatment. The increase of brightness is ranging between 15.53 and 28.60, meaning that the intensive color of sausage is red. The brightness of color (b) is reducing after *angkak* treatment by the rate between 15.58 and 17.78.

Result of ANOVA indicates that there is a significant influence ($p < 0.05$) of *angkak* treatment on the brightness of color L, a and b. This obvious difference is caused by different dose of *angkak* flour treatment. Red colored *angkak* is penetrating meat muscle during curing process. Meat color is affected by myoglobine level of the muscle and myoglobine type (depending on physical and chemical conditions, and other components). It is supported by previous research that affirms the compounds in *angkak* pigment are monascorubramine and rubropunctamine [10]. These compounds are the resultant of orange pigment oxidation, and the compounds will react with amino acids, polysaccharide amino and alcohol amino from which the red color is emerging.

The level of water holding capacity (WHC) in the sausage is showing obvious difference ($p < 0.05$). It is influenced by water content in the sausage. Furthermore, water content is influenced by protein

content within *angkak* used as curing material. Water content increases because protein binds water molecule through hydrogen binding. Water binding capacity is also influenced by pH. If pH is higher than isoelectric pH, the positive loads of the protein are coming out [11]. The positive loads exiting from the meat may be resisted by microfilament and therefore, water binding capacity is increasing. The release at pH in acidity condition and also with positive loads may produce the binding between meat protein and H molecule. Higher concentration of *angkak* treatment may increase WHC of the meat [12]. *Angkak* reaction may induce meat protein to be more positively loaded than to bind H^+ mutant, and therefore, neither of H^+ is free nor binding with O to produce free water molecule [13].

In Table 1, pH shows obvious difference ($p < 0.05$). Higher concentration of angkak treatment may reduce pH. Prinyawiwatkul [14] adds that *angkak* can stabilize pH, especially at range between 6 and 6.5. *Angkak* treatment can help controlling the growth of good microorganism on surface and inside tissue, and thus, anaerobic pollutant bacteria only grow slowly at pH below 5.6. pH of castoff duck meat is ranging between 6.1 – 6.2, whereas pH of *angkak* during measurement is 5.2 [15]. Therefore, it can be said that higher concentration of *angkak* treatment will reduce pH of duck meat sausage. It was reported that pH of duck meat sausage is averaged at 6.27 [16], but the mean of pH of duck meat sausage is 6.57 [17].

Chemical Characteristic of Duck Meat Sausage

Data, result of analysis of variance, and result of HSD test against water content, lipid rate, protein content, carbohydrate rate and dissolved protein rate in duck meat sausage are shown in Table 2.

Table-2: The Mean of Chemical Characteristic of Duck Meat Sausage

	***Angkak* Concentration**			
Parameters	**0%**	**1%**	**1.5%**	**2%**
Water	65.53 ± 0.57^{c}	64.60 ± 0.01^{b}	64.09 ± 0.01^{ab}	63.90 ± 0.01^{a}
Lipid	7.89 ± 0.02^{d}	7.83 ± 0.03^{c}	7.71 ± 0.01^{b}	$7.31 \pm 0.0\ 1^{a}$
Protein	12.03 ± 0.20^{a}	13.44 ± 0.17^{b}	14.34 ± 0.01^{c}	14.44 ± 0.01^{c}
Carbohydrate	8.96 ± 0.04^{a}	11.57 ± 0.01^{b}	11.90 ± 0.01^{c}	14.96 ± 0.02^{d}

Note: Different notation shows different treatment ($p < 0.05$)

The decline of water content in duck meat sausage is caused by the increasing concentration of *angkak* treatment. *Angkak* extract may oxidize during heating and thus, this condition eliminates water content within the meat. Treatment with various concentrations of angkak extract (*Monascus purpureus*) may induce meat protein to have positive load and to bind H^+ load, therefore, there is no free H^+ or no H^+ available to bind with O to produce free water molecule [18].

Protein content of the sausage increases because *angkak* treatment in this experiment is done by curing for 24 hours. This curing allows the accumulation of protein from duck meat and *angkak*. Moreover, *Monascus purpureus* fungus in this process has produced enzymes such as α-amylase, β-amylase, glucoamylase, lipase, protease, glucosidase, and ribonuclease that allow the fungus to grow onto the materials containing starch, protein and lipid [5]. The presence of fungus helps increasing protein content of duck meat sausage, especially by giving various concentrations of *angkak* treatment, including R_1, R_2, and R_3. It was reported that protein content of *angkak* is 11.60% [19]. Higher concentration of *angkak* may increase protein content of duck meat sausage. Indonesia National Standard determines that minimal protein content in the sausage is 13%. Research shows that protein content of duck meat sausage, along with *angkak* color maker, is ranging between 13.44 and 14.4%. Therefore, protein content of the sausage has met Indonesia National Standard.

Result of research indicates that lipid rate of sausage after *angkak* treatment tends to decline although the average rate is relatively similar. This relative similarity is found because the decline of lipid rate in *angkak* is only 1.58% [20], such that it will not influence the increase of lipid rate in food product. The decreasing lipid rate may be caused by lovastin compound in *angkak* which functions as the inhibitor to HMG-KoA Reductase (enzyme that functions in cholesterol biosynthesis). Lovastin can be hydrophilic and lipophilic, but it tends to lipophilic. This lipid rate ranges between 7.31 and 7.83%, whereas lipid rate, based on Indonesia National Standard, is maximally 25 %. Therefore, lipid rate in this research has met the standard.

Carbohydrate rate in this research is obviously different ($p < 0.05$). It is shown that the higher concentration of *angkak* treatment is the higher carbohydrate rate. Carbohydrate rate in *angkak* is 76.3%, such that the higher level of *angkak* treatment may increase carbohydrate rate of duck meat sausage [21].

Total Bacterial

Data, result of analysis of variance, and result of HSD test against total bacterial of duck meat sausage are shown in Table 3. The decline of bacterial total in duck meat sausage with *angkak* treatment at concentration 1%, 1.5% and 2%, may be caused by

angkak treatment that prevents bacteria growth from growing on meat curing. Besides being natural color maker, *angkak* is also anti-bacteria. The anti-bacterial compound within *angkak* is Ancalactone (rubropnuctatin and monascorubrin) [10]. The decline of bacterial total is also affected by pH of duck meat sausage. The acidity inside the meat is induced by meat preservation against bacteria [22]. Elizabeth and Lonergan [11] assert that most bacteria are not resistant to acidity because acidity can dehydrate bacterial cells such that bacterial liquid will exit of the cells and the cells may die. Higher concentration of *angkak* treatment may reduce microorganism level in duck meat sausage. The pH rate of duck meat sausage is always lower than normal pH, and this low pH can impair and prevent microorganism growth. Microorganism cannot grow at pH which is not support the life cycle. The lower pH occurs due to the higher concentration of angkak treatment, and it will reduce microorganism growth [21].

Table-3: The Mean of Total Bacteria in Duck Meat Sausage

***Angkak* Concentration**	**Mean and Deviation Standard**
R_0 : Without Angkak	6.86 ± 0.02^{d}
R_1 : 1.0 %	6.60 ± 0.02^{c}
R_2 : 1.5 %	6.53 ± 0.02^{b}
R_3 : 2.0 %	6.32 ± 0.02^{a}

Note: Different notation shows different treatment ($p < 0.05$)

Organoleptical Test

Data, result of analysis of variance, and result of organoleptical test against color, aroma, taste and texture of duck meat sausage with *Scoring for Intensity Test* are shown in Table 4.

Table-4: The Mean of Organoleptical Test Result

Parameters	**Concentration**				**Remarks**
	0%	**1%**	**1.5%**	**2%**	
Color	5.00	3.50	2.40	1.90	Significant
Aroma	3.50	3.95	3.95	4.05	Non-Significant
Taste	3.50	3.55	3.55	3.90	Non-Significant
Texture	2.40	2.25	2.30	2.62	Non-Significant

Organoleptical test against sausage color after *angkak* treatment at concentration 0%, 1%, 1.5% and 2%, may give obvious difference ($p < 0.01$). The characteristic of sausage color test is explained as follows: Score 1: bright red, Score 2: rather bright red; Score 3: red; Score 4: brownish red; and Score 5: pale brown. The panelist assessment against duck meat sausage can be described as follows: without *angkak* treatment (0%) is mean 5 (brown), *angkak* treatment at concentration 1% is mean 3.5 (between red and brownish red), angkak treatment at concentration 1.5% is mean 2.40 (bright red), and *angkak* treatment at concentration 2% is 1.9 (rather bright red). It means that the panelists like red sausage because it is attractive. Brown is the most disliked. The change into grays brown color is happening due to protein denaturing process. The color of processed meat product is also influenced by temperature and cook length [22].

The aroma caused by sausage at different *angkak* treatment is giving non-significant result. The characteristic of sausage aroma test can be explained as follows: Score 1: very plenty of duck meat aroma; Score 2: plenty of duck meat aroma; Score 3: rather plenty of duck meat aroma; Score 4: few duck meat aroma; and Score 5: no duck meat aroma. The panelist assessment against the mean of aroma is described as follow: 0%: 3.5; 1%: 3.95; 1.5%: 3.95; and 2%: 3.95. It means that panelist assessment against sausage with duck meat aroma remains in the range between 3.5 and 3.95. It is apparent due to the aroma of dominant flavor in duck meat sausage.

The taste produced by sausage at different concentration of *angkak* treatment is not different at all. Panelist assessment against taste test is explained as follows: Score 1: very plenty of duck meat taste; Score 2: plenty of duck meat taste; Score 3: rather plenty of duck meat taste; Score 4: few duck meat taste; and Score 5: no duck meat taste. This panelist assessment is ranging between 3.50 and 3.90, meaning that the characteristic is related to few duck meat taste. The taste of food material is affected by several factors such as chemical compound, temperature, consistency, and interaction with taste components such as cooking type and cooking length.

Organoleptical test against texture is giving less obvious difference ($p < 0.01$). The assessment against texture test is described as follows: Score 1: very soft; Score 2: soft; Score 3: rather soft; Score 4: harsh; and Score 5: very harsh. Panelist assessment in sausage texture test is ranging between 2.40 and 26.0, with the characteristic of texture remains between soft and rather soft categories. It is because the components inside the sausage have water binding capacity such as

the protein in duck meat and the protein of *angkak*, and thus, sausage texture is softer.

CONCLUSION

Angkak treatment in sausage preparation can maintain the quality of castoff duck meat sausage. The treatment with *angkak* concentration 1% is effective for *angkak* to be functioned as curing material and natural color maker in the preparation of castoff duck meat sausage.

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