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Effect of Additional *Curcuma mangga* Pulp or Filtrate on Chicken Meat Spoilage During Storage

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ABSTRACT

Chicken meat is a favoured animal ingredient, but its antimicrobial activity makes it perishable. Chicken meat can be stored frozen, but thawing takes a long time. *Curcuma mangga* Val. is antibacterial and has antioxidant activity that can extend the shelf life of an ingredient. The study aimed to determine the effect of adding *C mangga* pulp or filtrate on the damage of native chicken meat during storage. The treatments in the study controlled fresh chicken meat, chicken meat with the addition of *C mangga* pulp (DBT) and chicken meat with the addition of *C mangga* filtrate (DFT) with a storage time of 0, 3, 6, and 9 days at 4 °C. The testing parameters were water content, protein content, total plate count, *Salmonella* contamination, colour and pH. Free-range chicken meat with the addition of *C mangga* filtrate stored for three days showed a total plate number according to SNI, damaging *Salmonella* contamination, and lightness and pH were not significantly different from the control. The best result is the length of storage of native chicken meat with the addition of *C mangga* filtrate for three days.

Keywords: *Curcuma mangga*, chicken meat, shelf life

INTRODUCTION

Based on data from the Indonesian Ministry of Agriculture and BPS RI as of September 2020, there was a surplus in the availability of broiler chicken meat of 1,071,145 tons, with a total production of 3,272,141 tons and consumption of 2,200,996 tons. This surplus is due to the COVID-19 pandemic from March to December 2020 (BPS, 2020). This surplus of native chicken meat is a challenge for the food world, especially regarding its preservation. Chicken meat is often damaged due to improper handling, reducing shelf life (Jaelani and Dharmawati, 2014). Handling during processing, transportation, and storage will affect the microbiological quality of chicken meat (Rouger et al., 2017).

Quality parameters of native chicken meat that determine consumer choice include appearance, texture, juiciness, moisture content, firmness, tenderness, odour and taste (Akbar et al., 2017). Chicken meat is a suitable medium for the growth of microorganisms due to its high-water content. Adding *C mangga* can be an alternative to prevent meat damage because it is antibacterial. *C mangga* functions as an antibiotic because it can inhibit the growth of *E. coli* bacteria (Dewi et al., 2017). *C mangga* has antioxidants, flavonoids and phenolics such as epigallocatechin gallate, gallic acid, and curcumin (Putri and Pujimulyani, 2018). The content of curcuminoids in *C mangga* is 132 ppm (Pujimulyani, 2003) and polyphenols that function as antioxidants (Pujimulyani et al., 2023). Pressure blanching of *C mangga* can significantly increase antioxidants and improve lipid profiles in dried form (Pujimulyani et al., 2020). The minimum inhibitory concentration of *C mangga* against *S. aureus* was 1.2 µl/ml, and *B. cereus* was 11.2 µl/ml (Dosoky and Setzer, 2018). Research by Philip et al. (2009) showed the antibacterial activity of *C mangga* ethanol extract against *S. aureus* bacteria at a concentration of 50 mg/ml, which showed that *C mangga* has antibacterial activity.

Fresh meat must be stored at refrigeration temperature, a simple and frequently used method (Pestariati et al., 2003). Consolidating native chicken meat at refrigeration temperature is less effective because bacteria can still grow. Based on this description, a study was conducted on the addition of *C mangga* and the storage time of native chicken meat at refrigeration temperature on the damage of native chicken meat (moisture content, protein content, color, and pH).

MATERIALS AND METHODS

Materials and tools

The main ingredients were breast meat from a local Yogyakarta chicken supplier and *C mangga* rhizome from CV Windra Mekar. Chemicals used include Plate Count Agar (PCA), *Salmonella Shigella* Agar (SSA), distilled water, citric acid, methanol (Merck), absolute ethanol

(Merck), physiological NaCl (Merck) and DPPH (Merck).

The tools used consisted of petri dishes, refrigerator (LG GN B 185 SQBB), blender (Philips HR2116), analytical balance (Ohaus), funnel, Erlenmeyer (Pyrex), blender (Miyako), drop pipette, micropipette, measuring cup (Iwaki), falcon, measuring flask, oven (Memmert), beaker glass (Iwaki), test tube (Iwaki), digital scale (Camry), bunsen, cotton swab, measuring pipette (Pyrex), measuring cup (Iwaki), 250 ml erlenmeyer (Iwaki), 500 ml erlenmeyer (Iwaki), incubator, calliper, colorimeter (type NH310) and UV-VIS spectrophotometer.

Research method

Completely Randomized Design (CRD) 2 factors in each treatment, namely native chicken meat with the addition of *C mangga* pulp (DBT) and native chicken meat with the addition of *C mangga* filtrate (DFT). Three samples were observed on days 0, 3, 6 and 9. Furthermore, the samples were analyzed for water content, protein content, total plate count, *Salmonella* contamination, color and pH. The research was conducted over two months.

Preparation of *C mangga* pulp and filtrate

C mangga 1 kg that has been peeled is then blanched using the hot water blanching method in 1 Litre of 0.05% citric acid media that has been boiling for 5 minutes. The *C mangga* was drained, 500 g was taken, then crushed to obtain *C mangga* pulp, and 14 g were weighed each in 4 parts. The remaining pulp was taken at 200 g and filtered to obtain *C mangga* filtrate. The filtration results were taken at 14 g in 4 parts.

Carcass preparation

Twelve 100 g chicken breast pieces were packed in plastic wrap and added with *C mangga* pulp/filtrate (DBT/DFT). DBT or DFT was added by immersion and through coating 14% of the chicken's weight. After standing for 10 minutes, it was stored in a refrigerator at 4 °C and observed on days 0, 3, 6 and 9, including analysis of water content, protein, total plate count, *Salmonella* contamination, color and pH value.

Moisture content

The weighing bottle was heated in an oven at 105 ºC for 1 hour. Next, 1-2 g of sample was weighed and dried in an oven at 105 ºC for 3-5 hours. The weighing bottle was removed from the oven and weighed until a constant weight was obtained.

Protein content

Samples were weighed 0.1 g and put into a kjeldhal flask. They added 1 g K_2SO_4, 40 mg HgO, and 2 ml H_2SO_4. The sample was brought to a boil until the liquid was clear and put into a distillation device, and 8 ml of NaOH-$Na_2S_2O_3$ solution was added. Erlenmeyer added three drops of PP indicator and H_3BO_3 under the distillation device. The condensate was then titrated with 0.02 N HCl.

Total Plate Count (TPC) and *Salmonella* Contamination

A 25 g sample was weighed in a sterile petri dish, and 225 ml of physiological NaCl solution was added. The suspension was diluted: 10-1, 10-2, 10-3, 10-4, 10-5, 10-6 in duplicate. In the next stage, the suspension was added to sterile PCA media (Oxoid CM 0325) at 45 ºC as much as 15-20 ml. The media was allowed to solidify and incubated in an inverted position for 24-48 hours at 37 ºC. Microbial counts were based on Standard Plate Count (SPC) provisions, and the number of colonies was determined with the Bacteriological Analytical Manual (BAM).

Color Test

Samples at storage time (0, 3, 6, 9) days were tested for color with colourimeter type NH310, and then the scale (L*, a*, b*) was written. Tests were carried out two times, and the average was calculated.

pH measurement

Native chicken meat 10 g was added with 90 ml of distilled water crushed using a blender until homogeneous. Measurements were made using a pH meter with the pH electrode dipped into the meat solution.

RESULTS AND DISCUSSION

Moisture content

The moisture content of native chicken meat with the addition of *C mangga* pulp or filtrate (DBT/DFT) is presented in Table 1. The moisture content of free-range chicken meat with adding *C mangga* filtrate (DFT) significantly differed from the control treatment and adding *C mangga* pulp. Until day 6, the overall moisture content of the samples decreased. On day 9, the moisture content of all samples increased. It is believed to occur because connective tissue in chicken meat begins to degrade on day nine, releasing bound water and increasing water content (Rosmawati et al., 2020).

Table 1. Moisture content (%) of native chicken meat with the addition of *C mangga* pulp (DBT) and filtrate (DFT)

Treatment	Storage Duration (days) at ºC			
	0	3	6	9
Control	78.20 ± 0.43^{h}	74.20 ± 0.22^{c}	67.78 ± 0.19^{a}	74.57 ± 0.11^{cd}
DBT	76.10 ± 0.15^{f}	75.21 ± 0.21^{e}	70.77 ± 0.33^{b}	74.90 ± 0.35^{de}
DFT	78.40 ± 0.21^{h}	76.94 ± 0.05^{g}	67.70 ± 0.09^{a}	70.62 ± 0.16^{b}

Notes: Numbers followed by the same letter show no significant difference

The moisture content of chicken meat in each treatment showed the same pattern, which decreased until day six and increased on day 9. It occurs due to evaporation during storage as a form of balance with the environment. The increase in moisture content on day nine is a form of release of bound water in the material because the meat is damaged. It is in line with the research of Kaewthong et al. (2019) that storage temperature significantly affects changes in chicken meat's dry weight due to a decrease in the ability to bind water in myofibrils. Temperature, storage time, and microbiological growth are the main factors affecting water's binding ability with myofibrils in meat (Cheng and Sun, 2008; Ali et al., 2015). Microbial growth can be suppressed if there is little free water. Gupta et al. (2015) observed that pathogenic bacteria treated with *C longa* showed morphological damage in cytoplasmic membrane damage.

Protein Content

The protein content in chickens needs to be evaluated to understand the impact of protein intake from DBT and DBF on the chickens. The results of the protein content analysis of native chicken meat with the addition of *C mangga* pulp or filtrate (DBT/DFT) are presented in Table 2.

Tabel 2. Protein content (%db) of native chicken meat with the addition of *C mangga* pulp (DBT) or filtrate (DFT)

Treatment	Storage Duration (days)			
	0	3	6	9
Control	96.38 ± 2.92^{f}	91.72 ± 4.73^{de}	84.30 ± 1.66^{b}	70.46 ± 1.12^{a}
DBT	98.40 ± 1.67^{f}	95.53 ± 3.15^{ef}	88.33 ± 3.07^{bcd}	83.76 ± 2.27^{b}
DFT	98.66 ± 1.20^{f}	97.99 ± 1.82^{f}	89.37 ± 1.34^{cd}	84.94 ± 3.15^{bc}

Notes: Numbers followed by the same letter show no significant difference

Table 2 showed no significant difference in the protein content of DBT or DFT chicken meat. The protein content of the control chicken meat from day 3 was significantly lower than that of the supplemented filtrate. It is probably because protein is used as a source of nutrients for growing microbes. The control chicken meat is thought to have more microbial growth than those supplemented with *C mangga* filtrate. The high increase in Total Volatile Basic Nitrogen (TVBN) levels in chicken meat is due to the breakdown of protein compounds by proteolytic bacteria, which then causes a distinctive aroma of decay (Khulal et al*.,* 2017).

The protein content of chicken meat shows a value that tends to decrease from day 0 to day 9 of storage. It is thought to be the growth activity of chicken meat bacteria that utilize protein as a source of food nutrients. Research by Badai et al. (2017) on adding chitosan and clove oil to beef at room temperature and refrigeration temperature decreased during 32 days of storage. The decrease in protein is due to proteolytic enzymes produced by microorganisms that grow on meat. These enzymes can break down meat proteins, and proteins interact with chitosan.

The treatment of *C mangga* addition resulted in higher protein levels than the control. This condition shows the effectiveness of *C mangga* in inhibiting bacterial growth so that proteolytic enzymes that play a role in protein breakdown can be prevented. According to Susanti and Mahmudah (2017), *C mangga* can inhibit *S.aureus* at a concentration of 31.25 mg/ml due to the content of curcuminoids, flavonoids, polyphenols and essential oils that damage the bacterial cell membrane.

Total Plate Count (TPC)

The results of the total plate number test on chicken meat are presented in Table 3. The control showed a sharp increase from 2.1×10^5 CFU/g on day 0 to 4.00×10^6 CFU/g on day 9. DBT or DFT samples effectively inhibited total plate numbers or *Salmonella* contamination. TPC in DBT and DFT showed values below the 2009 SNI contamination requirement of 1×10^6 CFU/g (SNI, 2009). The lowest TPC value was found in DFT compared to DBT. This is because all parts of the chicken meat surface can absorb the filtrate preparation more easily. According to Susanti and Mahmudah (2017), *C mangga* can inhibit the growth of *S. aureus* at a concentration of 31.25 mg/ml.

Table 3. Total plate count of native chicken meat with 14% *C mangga* pulp (DBT) or filtrate (DFT).

Treatment	Storage Duration (days)			
	0	3	6	9
Control	2.1×10^5	2.39×10^6	4.00×10^6	4.00×10^6
DBT	2.2×10^5	5.1×10^5	8.9×10^5	9.0×10^5
DFT	2.0×10^5	2.2×10^5	5.2×10^5	6.2×10^5

Notes: Numbers followed by the same letter show no significant difference

TPC of the three treatments showed an increase during storage. DBT, DFT and control increased on days 3, 6 and 9. The increase in TPC of the control on day three did not meet the SNI requirements, while the DBT or DFT until storage on day nine still met the requirements. This difference shows the role of *C mangga* in inhibiting microbial growth. Inhibition of bacterial growth by *C mangga* is due to flavonoid compounds and essential oils and polyphenols in it (Dewi et al., 2017). Chicken meat treated with the addition of *C mangga* filtrate is the most effective way to suppress bacterial growth. The minimum inhibitory concentration of *E. coli* bacteria by *C mangga* rhizome is 10 mg/ml, and the maximum inhibition at 50 mg/ml is 6.83 mm (Sarjono & Mulyani, 2007).

Salmonella contamination

Salmonella contamination values are presented in Table 4. Based on Table 4, all treatments showed negative values for *Salmonella* contamination. It indicates that the samples of native chicken meat have met the requirements of SNI 3924-2009. Budiarso and Belo's (2009) research on *Salmonella* contamination in chicken meat in several markets in Yogyakarta found 20% positive contamination. In contrast, Bakara et al. (2014) said that several factors can cause the presence of *Salmonella* bacteria in a food product. These factors include unfavorable conditions and the presence of other bacterial contaminants, such as LAB, that can inhibit the growth of *Salmonella*.

Table 4. *Salmonella* contamination of chicken meat with the addition of *C mangga* pulp (DBT) or filtrate (DFT)

Treatment	Storage Duration (days)			
	0	3	6	9
Control	Negative	Negative	Negative	Negative
DBT	Negative	Negative	Negative	Negative
DFT	Negative	Negative	Negative	Negative

Color

Color is measured using the L*, a* and b* value parameters. The L* value (Lightness) ranges from 0 (black) to 100 (white) while the a* value (redness) and b* value (yellowness) (Kralik et al., 2018). The measurement of L*, a*, and b* values of chicken meat treated with no addition, as well as the addition of *C mangga* pulp or filtrate, is presented in Table 5.

Table 5 shows that the control chicken meat has a lower L* value (darker) than DBT and DFT. It is due to the oxidation of fat contained in the chicken meat. This condition is in line with the increase in storage time. The longer the storage time, the lower the L* value, which means the darker the color. According to Shen et al. (2015), changes in meat color during storage are generally caused by water loss and lipid oxidation. The treatment that gives the best color

Table 5. L*, a* and b* color values of native chicken meat with the addition of *C mangga* slurry (DBT) or filtrate (DFT).

Treatment	Storage Duration (days)	Color Value		
		L*	a*	b*
Control	0	50.45±0.27^{de}	9.60±0.03^{d}	12.53±0.16^{f}
	3	50.08±0.44^{d}	10.62±0.16^{f}	11.37±0.34^{de}
	6	48.98±0.16^{c}	8.42±0.35^{b}	11.07±0.46^{cd}
	9	42.51±0.07^{a}	9.84±0.11^{d}	10.36±0.06^{b}
DBT	0	52.09±0.15^{g}	10.25±0.18^{e}	11.54±0.19^{e}
	3	50.68±0.32^{de}	8.37±0.07^{ab}	11.24±0.08^{cde}
	6	46.73±0.07^{b}	11.45±0.08^{g}	10.89±0.10^{b}
	9	42.23±0.44^{a}	10.53±0.04^{ef}	9.35±0.09^{a}
DFT	0	52.96±0.18^{h}	9.61±0.07^{d}	13.95±0.12^{g}
	3	51.06±0.22^{ef}	8.34±0.20^{ab}	14.24 ± 0.18^{g}
	6	51.35±0.86^{f}	8.10±0.24^{a}	14.06 ± 0.35^{g}
	9	47.05 ± 0.11^{b}	8.72±0.22^{c}	12.38 ± 0.05^{f}

Notes: Numbers followed by the same letter in the column indicate no significant difference.

is the treatment of chicken meat that adds *C mangga* filtrate because it gives a brighter color.

The three treatments' a* and b* values in the chicken meat samples showed significant differences ($P < 0.05$). It is thought to be the inhibition of hemoglobin oxidation in the formation of oxymyoglobin pigment compounds found on the surface of the meat. According to Zhou et al. (2010), oxymyoglobin is an essential pigment in the acceptance of fresh chicken meat color and only exists on the surface of the meat.

pH value

The pH values of DBT and DFT can be seen in Table 6. The pH value of chicken meat showed significantly different values. It is thought to result from microbial activity breaking down proteins into amino acids. Research by Jaelani and Dharmawati (2014) showed a decrease in the pH of broiler chicken meat stored in plastic packaging at a temperature of 4 ºC due to microbial activity that causes the process of glycolysis to produce lactic acid.

Table 6. pH value of native chicken meat with the addition of *C mangga* pulp (DBT) or filtrate (DFT).

Treatment	Storage Duration (days)			
	0	3	6	9
Control	6.31±0.04^{cde}	6.31±0.07^{cde}	6.26±0.06^{abcd}	6.24±0.02^{abc}
DBT	6.23±0.04^{ab}	6.19±0.03^{a}	6.44±0.02^{f}	6.55±0.02^{g}
DFT	6.28±0.02^{bcde}	6.33±0.02^{de}	6.35±0.06^{e}	6.64±0.02^{h}

Notes: Numbers followed by the same letter show no significant difference

The length of chicken meat storage in this study showed significantly different values between observation times, especially after 6 days of storage. Research conducted by Wala et al. (2016) stated that although the pH value in the study was higher, the difference in pH value could only be shown in the observation after the 6th day.

The pH value of chicken meat treated with the addition of DFT during 9 days of storage was the highest and significantly different. It is in line with the effectiveness of the filtrate in reducing the total plate count in chicken meat. According to Septiana and Simanjuntak (2015), antioxidant compounds found in turmeric and extracted using ethyl acetate from the roots, stems, and leaves can provide inhibition of *S. aureus, E. coli* and *C. albicans* bacteria.

CONCLUSIONS

Adding 14% *C mangga* pulp or filtrate to chicken meat through immersion can reduce the risk of spoilage during 3-day storage in the refrigerator. The most effective treatment inhibiting bacterial growth is immersing 14% *C mangga* filtrate with result TPC $2.2x10^5$, pH 6.33, which maintains a brighter and significantly different color but inhibits slightly higher protein content than the other two treatments.

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