Jurnal AA Putra et al

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International Journal of Poultry Science 10 (1): 62-70, 2011 ISSN 1682-8356 © Asian Network for Scientific Information, 2011

Changes During the Processing of Duck Meatballs Using Different Fillers after the Preheating and Heating Process

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Abstract: In the process of manufacturing duck meatballs, three different fillers (corn, sago and cassava) are used as representatives of grain, root and palm sources of fillers. Different stages of duck meatball processing, such as dough, pre-heating and heating, were analyzed to further the research on the manufacturing process of duck meatballs. In this study, the nutritional contents, physicochemical characteristics and sensory attributes are collected. In general, there were no significant differences ($p>0.05$) among the fillers in the characteristics that we examined. However, there were significant differences ($p<0.05$) among the different stages of the processing. After preheating and heating, the moisture contents were significantly increased ($p<0.05$) and the increase in moisture content directly caused other nutrient components to decrease. The pH, lightness, texture, cooking yield, moisture retention, diameter and folding test results were increased ($p<0.05$) after the preheating and heating stages. Cassava treatment showed a significant higher ($p<0.05$) in the terms of aroma of the final products meanwhile other sensory attributes were not significantly different ($p>0.05$). Sensory evaluation for overall acceptability showed that all treatments were acceptable.

Key words: Meatball, duck meat, filler, processing, physicochemical, sensory

INTRODUCTION

Meatballs are a common meat based food product in Asia. Meat balls are usually made of minced meat that is bound together by filler as binder. Several spices and water are also added into meatballs. This product is usually prepared by boiling in East Asia and Southeast Asia and is often eaten with noodles and a sauce. In other regions, however, the meatballs are fried and ready-to-eat.

Beef, chicken and fish are the dominant components in meatballs sold in the market. However, in order to diverse meatball products and to improve other meat consumption in society, other potential meat can be used to make meatballs. Developments in seafood production and consumption has resulted in using shrimp and prawn (limited quantity) to make meatballs, however, meatballs made of poultry other than chicken are not common. Thus, it is important for the meatball processing sector to develop meatballs with poultry meat - in addition to chicken - that is available at market scale quantities.

In Asia, duck meat is the second dominant poultry meat in use after chicken meat. However, the recent application of this meat in making food products is still limited. Moreover, producing duck meat ready-to-eat meatballs will help to improve the poultry meat type production chain.

In producing the required quality for duck meatballs, especially the texture quality, starch is needed. The ability of starch to retain water and process gelatin impacts the texture of duck meatballs. These characteristics create different proximate compositions and affect the sensory evaluation by consumers. Approximately 60 million tons of starches are extracted annually for different utilizations (FAO, 2006). Important functional properties of starches plays role in food product manufacturing and it have been contribute to different varieties of food products (Singh *et al.,* 2003).

Several fillers and extenders of meatballs, such as legume flours (Serdaroglu *et al.,* 2004), rye bran (Yilmaz, 2004), rice bran (Huang *et al.,* 2005), wheat bran (Yilmaz, 2005), wheat flour, whey protein concentrate, and soya protein isolate (Ulu, 2004) have been recently investigated for different purposes by researchers. However, other starch sources, such as sago, corn and cassava flour, also have potential to be applied to the production of duck meatballs at a market scale because they are economical and have a high availability rate.

There are three cereals that dominate the world grain economy; wheat, rice and maize. Since many paddy field dominated by many developing countries, rice placed first important cereal in many developing countries, followed by wheat and maize in the second and third place (Morris, 1998).

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However, the maize utilization has been known as the highest quantity in many processed food (Hirashima *et al.,* 2005a). Recently, maize starch has been used by researchers to produce many food products, such as paste (Hirashima *et al.,* 2005a), bologna-type sausage (Aktas and Cenccelep, 2006), battered products (Salvador *et al.,* 2006) and noodles (Yalcin and Basman, 2008).

Other studies have focused on cassava. The cultivation of cassava is found in tropical areas, where many foods and animal fodders are produced from this product (Kosugi *et al.,* 2009). The use of cassava flour in food products, such as paste (Che *et al.,* 2009), linguiQa (Brazilian pork sausage) (Rocco *et al.,* 2003), crackers (Tongdang *et al.,* 2008) and fried cassava balls (Chinma and Igyor, 2008), has been recently targeted by researchers.

Sago is a popular palm in Indonesia and Malaysia. Nevertheless, because of its poor and varying quality, sago has not been fully used in food formulations (Ariff *et al.,* 1997). Sago-derived starch has been developed as a food ingredient in noodles, vermicelli (beehoon), Kuah-Tiau and biscuit production (Abd-Aziz, 2002).

Changes in dough texture between uncooked and cooked meatballs will be found during food processing. These changes can affect the nutrient and physicochemical values of the products. The final meatball product indicates if different types of binder will give different results. Furthermore, the data may provide details to suggest that duck meatballs should be commercially manufactured on a market sized scale.

Heat treatments are usually used for cooking in the household kitchen. In industry, heat treatments are also used during pre-manufacturing to produce the final product (Loliger, 2000). The final texture of the product is influenced by these heat treatments, especially products using flour as a binder e.g., sausages, nuggets and meatballs. In many comminuted meat products, boiling and steaming are the most method used during manufacturing (Zhang *et al.,* 2004). Hot water treatment causes the changes in the structure of starches (Mohd. Nurul *et al.,* 1999). In starch gelatinization, starch is processed from a semi-crystalline, which is in a relatively dissolved form, into a fully dissolved form (Tester and Debon, 2000).

Preheating indirectly activates the annealing process of starches as binders in duck meatball processing; the actual function of preheating is to strengthten the texture in the outer part of the meatballs. The meatballs will then not be easily broken up through preheating when the temperature is close to the boiling point of water.

The heating process, after the preheating step will produce a strong texture of the final duck meatballs. In this process, meat and spices will bind the starch that is glutted with amylase and amylopectin during heating.

The rheological property of starches is affected by heating temperature and shear rates (Lagarrigue and Alvarez, 2001) and this phenomenon affects the textural properties of starch based products.

Starches are selected in this study to represent the different types of available plant starches. There are three types of starch in this research that are used to make a duck meatball formulation; grain, root and palm. Corn (Zea *mays)* was chosen to represent a grain starch, cassava *(Manlhot esculenta)* was chosen to represent a root starch and sago *(Metoxylon sago)* was chosen to represent a palm starch.

MATERIALS AND METHODS

Duck meatballs manufacturing: This study used Peking duck *(Anas platyrhynchos domestlcus)* meat. Soon after the ducks were slaughtered, they were ground using a machine. The emulsified meatballs were processed according to the steps shown in Fig. 1. Duck meatballs were processed with the following formula: 70% meat, 8% flour, 2.3% garlic, 1.5% fried onion, 0.2% pepper, 2.5% salt and 15.5% ice. After processing, the duck meatballs were analyzed in the laboratory.

Proximate analysis: The AOAC method (AOAC, 2000) was used to determine the macronutrient content of the meatballs: The moisture content was determined by drying the samples overnight at 105°C, the crude protein content was determined using the Kjeldahl method, the Soxhlet method was used to determine lipid content and the samples were ashed overnight at 550°C to determine ash content. The carbohydrate was calculated by difference.

PH : The pH value was determined by mixing 5 g of sample in a beaker glass with 45 ml of distilled water with a homogenizer (IKA® T25 digital Ultra-Turrax, Germany). After the homogenization process, the pH values were measured with a pH meter (Mettler Toledo Delta 320, Shanghai, China).

Color: Color measurement was done using the color profile system of lightness (L*), redness (a*), yellowness (b*), chroma (c*) and hue angle (H°) that was measured by a reflectance colorimeter (Minolta Spectrophotometer CM-3500d, Japan). The white ceramic tile used as standard for colorimeter calibration during analysis (CIE, 1978).

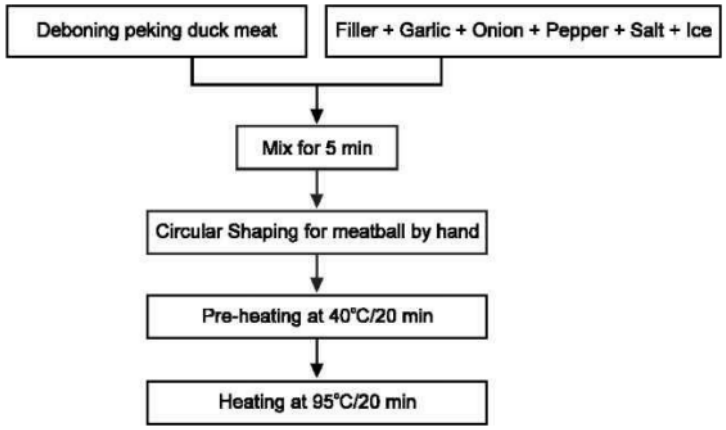

Fig. 1: Scheme of the duck meatball manufacturing process

Texture profile analyses: Texture Profile Analyses (TPA) was done using a texture analyzer (Model TA-XT2 Texture Analysis, England). The conditions of the texture analyzer were based on the following setting: pre-test speed of 2.0 mm/s, test speed of 5.0 mm/s, post-test speed of 5.0 mm/s, distance of 5.0 mm, time of 5.0 s, auto trigger type and trigger force of 10 g. The meatballs were cut on two sides to get a strip 10 mm in depth for TPA measurement. Each strip was immobilized between specially constructed stainless steel platters with the cut surface oriented. The spherical probes (P/0.5; 0.5-cm diameter ball probe) of texture analyzer penetrated the strip perpendicular to the duck meatballs (Huang *et al.*, 2005).

Cooking yield: Cooking yield was calculated based on a modified method as follows:

$$\text{Cooking yield (\%)} = \frac{\text{Final weight of meatball}}{\text{Initial weight of meatball}} \times 100$$

(Murphy a/., 1975)

Diameter changes: Diameter changes (%) were calculated based on a modified method as follows:

$$\text{Diameter reduction (\%)} = \frac{\text{Initial weight of meatball - Final weight of meatball}}{\text{Initial weight of meatball}} \times 100$$

(Serdaroglu and Degirmencioglu, 2004)

Folding **test:** The folding tests were determined by first cutting cooked meatballs into a 3 mm thickness. The test specimen was held between thumb and forefinger to observe the way it broke, which was evaluated based on the following scale: (1) breaks by finger pressure, (2) cracks immediately when folded into half, (3) cracks gradually when folded into half, (4) no crack showing after folding in half and (5) no crack showing after folding twice (Lanier, 1992).

Moisture retention: Moisture retention was calculated based on a modified method as follows:

$$\text{Moisture retention (\%)} = \frac{\text{(\% yield)x (\% moisture meatbail)}}{100}$$

(El-Magoli a/., 1996)

Fat retention: Fat retention was calculated based on a modified method as follows:

$$\text{Fat retention (\%)} = \frac{\text{(Final fet content in meatball) x (Final weight)}}{\text{(Initial fet content in meatball) x (Initial weight)}} \times 100$$

(Murphy a/., 1975)

Juiciness: Juiciness was determined as follows: the meatbail sample was taken from the center and was cut into 3-mm pieces with a knife. A sample was placed between two pieces of pre-weighed Whatman (No. 41) filter paper, covered with aluminum foil and pressed for 1 min by 10 kg of force. The residue was removed and the filter paper was weighed. The extracted juice was determined as follows (Gujral *et al.*, 2002):

$$\text{Juiciness (\%)} = \frac{\text{Weight of filter paper after pressing - Weight of filter paper before pressing}}{\text{Voight of wet sample}} \times 100$$

Sensory evaluation: The sensory evaluation was determined by serving warm meatballs to a 30 member panel using seven scale evaluations. The evaluation of duck meatballs was conducted using seven hedonic scales (Abdullah, 2000). The sensory attributes were lightness, taste, aroma, meatiness, toughness, juiciness and overall acceptance.

Statistical analysis: The data from six replications were analyzed using ANOVA test and t-test of Statistical Package for Social Science version 11.5.

RESULTS AND DISCUSSION

Proximate composition of dough, preheated and heated duck meatballs: An increasing amount of moisture content during processing is shown in Table 1. Improvement in moisture contents due to all filler treatments occurs due to the preheating that is actually done to create a pre-textured and perfectly cooked meatball, so as to obtain the optimum final product. The gelatinizing step conducted during processing causes the moisture improvement after preheating and heating. The differences in the gelatinization ability of each flour causes different water absorption points during preheating and heating, which allows the binder to take up water. In this study, however, the role of protein in duck meat was also important in water binding.

Heat treatment led the structure loss of the starch granules and this cause the water used enters the inside granules structures. As the heating continues, more water enters the starch granules easier (Vaclavic and Christian, 2003). When the water around the starch granules existed in higher quantities, the adsorption of water by starch granules occur easier (Tester and Debon, 2000).

The dough has limited water uptake, although ice is added to the duck meatball formulation. The dough in duck meatballs has a tendency toward increasing moisture content after preheating and heating.

Furthermore, during preheating, the mobilization of water continues in the starch granules, even though the preheating temperature is not high enough to initiate the gelatinization process.

Amylose is the important component in determine the rate of water absorption, swelling abilities and gelation properties of starch during food processing. Therefore, products that need quick-setting gels usually use the sources of polysaccharides with high quantity of amylose percentage (Niba, 2005). The amylose content of native cassava has been reported to be 21.43% (Shariffa *et al.,* 2009).

Amylopectin also influences gelatinization. Therefore, a high percentage of amylopectin in starches is necessary when a low percentage of amylose is present; this will balance the water absorption process in the duck meatballs. Similar with amylose, amylopectin is also affected by the existence of heat and water. During heating condition of starch in water, the amylopectin also release from the granules but relatively required a longer time compared to amylose (Hirashima *et al.,* 2005b). During gelatinization, the melting process of amylopectin structure causes the swelling of starches (Mohameed *et al.,* 2006).

There were no significant differences (p>0.05) among the three starches in the total solids except protein. However, there was a tendency for all of the total solid components to decrease when the amount of water was increased after the preheating and heating process. The protein percentage in duck meatballs, the second main nutritional component in duck meatballs, was significantly decreased (p<0.05) after the preheating and heating process.

The decreasing tendency in the amount of total solids in the duck meatballs was apparent after the preheating and heating processes. This phenomenon was caused

Table 1: Proximate compositions of dough, uncooked and cooked duck meatballs using corn, sago and cassava as fillers

Proximate composition	Processing step	Filler		
		Com	Sago	Cassava
Moisture	Dough	68.92^{aC}±0.54	69.16^{aC}±0.99	69.28^{aB}±0.17
	Preheating	70.64^{aB}±0.97	70.32^{aB}±0.65	71.24^{aB}±0.76
	Heating	71.68^±0.18	71.78^{aA}±0.95	72.30^{aA}±0.98
Protein	Dough	13.32^{aB}±0.49	13.19^{aB}±0.60	13.15^{aA}±0.82
	Preheating	12.92^{aAB}±0.55	12.80^{aAB}±0.31	12.91 ^{aA}±0.70
	Heating	12.65^±0.51	12.47^{aA}±0.40	12.25^{aA}±0.78
Fat	Dough	7.59^{Aa}±0.41	7.67^{Aa}±0.69	7.62^0.51
	Preheating	7.43^{Aa}±0.80	7.42^0.48	7.40^0.65
	Heating	7.22^{Aa}±0.36	7.32^{Aa}±0.86	7.23^{Aa}±0.72
Ash	Dough	3.56^{Aa}±0.26	3.48^{Aa}±0.39	3.53^{Aa}±0.45
	Preheating	3.35^{Aa}±0.36	3.29^0.40	3.32^0.39
	Heating	3.10^{Aa}±0.45	3.12^0.61	3.15^0.37
Carbohydrate	Dough	6.61^{Aa}±0.47	6.50^1.43	6.41^{Aa}±0.87
	Preheating	5.66^{Aa}±1.76	6.17^{Aa}±0.96	5.13^1.27
	Heating	5.36^{Aa}±0.83	5.33^1.27	5.08^{Aa}±1.56

*Means with different small letters among columns are significantly different (p<0.05) are significantly different (p<0.05). Means with different capital letters among rows by an indirect impact of increased moisture content during processing. Moisture increased due to the reduction in the percentage of other nutrients although there is no protein and carbohydrate released during processing. The ash that is soluble in water may be a reason for the tendency toward reduced total solid content, a theory that is supported by the moisture intake during processing. Moreover, salt solubility in water as a heat medium also influences the tendency of the total solids to decrease. The moisture that was absorbed during processing may be higher than the fat released during processing.

Physicochemical characteristic of dough, preheated and heated duck meatballs: There was an improvement in pH during the preheating and heating process with the three different fillers (corn, sago and cassava) (Table 2). Heat treatment during processing blocks the acidifying process that occurs in the dough after the meat in duck meatballs were mixed with the filler, which contains high carbohydrate levels. The different pH levels among the corn, sago and cassava fillers used in the duck meatball products influenced the different pH values of the dough; the corn fillers had a lower pH value than the sago and cassava fillers. The differences in total carbohydrate content in the preheated and heated processes indirectly impacted the moisture absorption, resulting in different pH values among the various fillers. The lower carbohydrate percentage in uncooked and cooked meatballs results in higher pH values.

The changes in color that occur during heating and preheating are shown by the increases in L* and H° values during processing, whereas a*, b* and c* values decreased. The changes were caused by the deterioration of myoglobin and metmyoglobin due to the improvement in the temperature during processing of the duck meatballs. The absorption of water by the meatballs resulted in an improvement in lightness and reduced the red-brown color of the meatballs. Different fillers had different color results in dough, during preheating and during the heating of the meatballs. These differences may be the cause of the different colors for the end products.

Table 2: pH, color and texture of dough, uncooked and cooked duck meatballs using corn, sago and cassava as fillers

		Filler		
Characteristics	Processing step	Corn	Sago	Cassava
pH	Dough	6.04^{aA}±0.04	6.11^{bA}±0.02	6.11^{bA}±0.01
	Preheating	6.20^{aB}±0.02	6.26^{cB}±0.03	6.16^{bB}±0.02
	Heating	6.26^{aC}±0.01	6.35^{cC}±0.03	6.30^{bC}±0.03
L*	Dough	51.70^{bA}±0.54	48.56^{aA}±0.17	52.29^{cA}±0.23
	Preheating	52.61 ^{bB}±0.25	49.24^{aB}±0.68	52.92^{bA}±0.86
	Heating	55.98^{cC}±0.97	53.38^{aC}±0.30	54.77^{bB}±0.44
a*	Dough	3.31^{aB}±0.16	3.58^{abC}±0.10	3.45^{aC}±0.17
	Preheating	3.19" ±0.23	3.28^{B}±0.23	3.09^{B}±0.20
	Heating	2.03^{A}±0.25	1.97^{A}±0.18	1.92" ±0.20
b*	Dough	16.67^{bC}±0.35	15.35^{aC}±0.04	16.88^{bC}±0.06
	Preheating	15.40^{bB}±0.61	14.08^{aB}±0.53	15.72^{bB}±0.57
	Heating	12.84^{A}±0.27	12.09* ±0.84	12.43^0.51
c*	Dough	17.00^{bC}±0.32	15.76^{aC}±0.06	17.22^{bC}±0.08
	Preheating	15.73^{bB}±0.55	14.46^{aB}±0.49	16.03^{bB}±0.58
	Heating	12.93^{bA}±0.19	12.05^{aA}±0.63	12.58^{abA}±0.48
H°	Dough	78.71^{bB}±0.78	76.86^{aB}±0.33	78.61 ^{bB}±0.45
	Preheating	78.75^{bB}±0.94	76.87^{aB}±1.24	78.89^{bB}±0.58
	Heating	80.97^{aA}±1.23	80.50^{aA}±1.26	81.16^{aA}±1.21
Hardness (g)	Dough	70.03^{aC}±0.35	68.60^{aC}±0.62	67.07^{aC}±0.51
	Preheating	91.63^{aB}±0.69	89.37^{aB}±0.75	87.87^{aB}±0.48
	Heating	459.97^{aA}±0.91	455.82^{aA}±0.89	446.28^{aA}±1.00
Cohesiveness	Dough	0.71^{aC} ±0.01	0.71^{aC} ±0.01	0.73^{aC}±0.01
	Preheating	0.81^{aB}±0.01	0.82^{aB}±0.01	0.83^{aB}±0.01
	Heating	0.98^{aA}±0.01	0.98^{aA}±0.01	0.97^{aA}±0.01
Springiness	Dough	0.94^{aB}±0.01	0.95^{aB}±0.01	0.94^{aB}±0.01
	Preheating	0.94^{aB}±0.01	0.95^{aB}±0.01	0.95^{aB}±0.01
	Heating	4.74^{aA}±0.01	4.74^{aA}±0.02	4.71^{aA}±0.01
Gumminess	Dough	49.44^{aC}±0.62	48.91 ^{aC}±0.63	48.75^{aC}±0.61
	Preheating	74.04^{aB}±0.90	73.28^{aB}±0.80	73.48^{aB}±0.18
	Heating	450.01 ^{aA}±1.02	445.32^{aA}±1.22	434.00^{aA}±1.09
Chewiness	Dough	47.08^{aC}±0.92	46.59^{aC}±0.63	46.00^{aC}±0.69
	Preheating	70.47^{aB}±0.74	69.51^{aB}±0.68	69.36^{aB}±0.53
	Heating	2132.83^{aA}±0.61	2112.03^{aA}±1.32	2043.77^{aA}±0.59

*Means with different small letters among columns are significantly different ($p<0.05$) are significantly different ($p<0.05$) .Means with different capital letters among rows

The alteration of duck meat myoglobin used in meatball formulation may cause changes in color after different heating treatments. Meat color is changes from red or purple to a pale gray as the breakdown of myoglobin structure during cooking (Vaclavic and Christian, 2003). In denaturation of meat color, the progress of turning the globin chain of myoglobin is done by high temperatures up to 60°C (Tarte and Amundson, 2006).

There were no significant differences ($p>0.05$) in texture among the three fillers, although significant texture differences ($p<0.05$) were observed in the steps of processing. The hardness of dough increased with the preheating and heating processes. The meat and other components that are bound by starch acts as glue. High temperatures caused the binding ability of starch to increase until a strong texture was obtained, which created a compact texture and a high cohesiveness of the product. The existence of moisture in starch granules, supported by a stronger texture, caused the duck meatballs to have an increase in springiness after heat treatment. The increase in gumminess was caused by the heating process inducing gelatinization. Higher temperatures resulted in increased gelatinization that created higher gumminess after the starch granules were broken. The texture of the meatballs was springy and gummy, which improved the chewiness.

There was no significant difference ($p>0.05$) among the three fillers with respect to cooking yield, but the cooked yield of cooked duck meatballs was significantly lower ($p<0.05$) than the yield of uncooked duck meatballs. The moisture intake of the different fillers after being cooked was minimized by moisture released from the meat during processing. Protein loses its ability to bind water in the presence of high temperatures. Thus, the absorption of water was by the binder starch even though moisture was released from meat proteins.

Diameter changes of the meatballs was not significantly different ($p>0.05$) among the three different fillers after preheating and heating. There were improvements in diameter after heating when compared to preheating.

The increased diameter was caused by the loss of the basic starch structure due to the heating process. Heating processes break starch granules, allowing easy access of water and resulting in swelling of duck meatballs.

Similar results were shown with the folding test among the different fillers. Preheating was not sufficient to create a strong texture for the duck meatballs because they were broken only by finger pressure. However, preheating duck meatballs created the pre-final texture that gave the optimum texture in the final product. After heating, all of the filler treatments showed optimum folding results, with the fifth point of folding giving the highest value. Optimum texture was obtained by improving the temperature from the preheating to heating process. The optimum point in the folding test may have been influenced more by the freshness of the meat used in the manufactured duck meatballs than by the fillers. The freshness of the meat may be a predictor of the folding test score, as is the meat species, the source of starch and the ingredients used in formulation (Nurul *et al.,* 2010).

There were no significant differences ($p>0.05$) in moisture retention of the duck meatballs among the type of binders or between the heating and preheating processes. When the moisture contents during preheating and heating were compared, it was apparent that moisture intake occurred during processing. After preheating, the moisture retention of corn, sago and tapioca duck meatballs (72.53, 72.84 and 73.33%, respectively) was higher than the actual moisture of corn, sago and tapioca duck meatballs (70.64, 70.32 and 71.24%, respectively). A similar result was also found after heating, with the moisture retention of corn, sago and tapioca duck meatballs (72.46, 72.59 and 72.94%, respectively) being higher than the actual moisture of corn, sago and tapioca duck meatballs (71.68, 71.78 and 72.30%, respectively). Protein and starches are compounded to bind water that is released during the denaturation caused by heating, especially in

Table 4: Sensory evaluation of cooked duck meatballs using corn, sago and cassava as fillers

	Filler		
Sensory attributes	Corn	Sago	Cassava
Color	5.26^{a}±0.71	5.22^{a}±0.97	5.26^{a}±1.02
Taste	5.00^{a}±1.11	5.26^{a}±0.94	5.30^{a}±1.30
Aroma pleasability	4.78^{b}±1.34	4.96^{ab}±1.02	5.56^{a}±1.16
Aroma meatiness	4.85^{b}±1.29	4.70^{b}±1.07	5.48^{a}±0.85
Toughness	5.37^{a}±1.15	5.56^{a}±1.09	5.41^{a}±1.25
Juiciness	5.26^{a}±1.13	5.30^{a}±0.87	5.52^{a}±1.05
Overall	5.11^{a}±1.01	5.11^{a}±0.93	5.30^{a}±1.07

Table 3: Cooking yield, diameter changes, folding test, moisture retention, fat retention and juiciness of preheating and heating duck meatballs using I corn, sago and cassava as fillers

		Filler		
Characteristics	Processing step	Com	Sago	Cassava
Cooking yield	Preheating	102.75^{aA}±0.76	103.24^{aA}±0.84	102.79^{aA}±0.51
	Heating	100.96^{aB}±0.48	101,01^{aB}±0.50	101,66^{aB}±0.67
Diameter changes	Preheating	0.86^{aB}±0.27	0.87^{aB}±0.27	0.95^{aB}±0.51
	Heating	1.54^{aA}±0.32	1.72^{aA}±0.27	1.63^{aA}±0.51
Folding test	Preheating	1.00^{aB}±0.00	1.00^{aB}±0.00	1.00^{aB}±0.00
	Heating	5.00^{aA}±0.00	5.00^{aA}±0.00	5.00^{aA}±0.00
Moisture retention	Preheating	72.53^{aA}±1.36	72.84^{aA}±0.48	73.33^{aA}±0.68
	Heating	72.46^{aA}±0.33	72.59^{aA}±1.18	72.94^{aA}±1.00
Fat retention	Preheating	97.61 ^{aA}±1.16	97.51^{aA}±1.18	97.64^{aA}±0.85
	Heating	97.90^{aA}±1.48	97.46^{aA}±1.50	97.49^{aA}±1.26
Juiciness	Preheating	-	-	-
	Heating	5.32^{a}±0.87	5.42^{a}±0.83	5.43^{a}±0.39

*Means with different small letters among columns are significantly different ($p<0.05$). Means with different capital letters between rows are significantly different ($p<0.05$) using a t-test

*Means with different letters among columns are different significantly ($p<0.05$)

meat product processing. Meat products are often manufactured with amylase-based starches because of its low gelatinization temperatures, high water-holding capacity and tendency to provide form to meat products (Mitolo, 2006).

There were no significant differences in fat retention ($p>0.05$) among the fillers or between the preheating and heating processes. The release of fat during preheating and heating caused the fat percentage to decrease in cooked compared to uncooked meatballs. Meanwhile, the moisture intake during processing was responsible in decreasing the fat retention of the product.

There were no significant differences ($p>0.05$) in juiciness among corn, sago and cassava, which correlated with the moisture content of the duck meatballs. Moisture influences the total water that is released during pressing in the juiciness analysis. Although the moisture content of cooked duck meatballs was slightly higher in cassava than in the other two fillers, there were no significant differences ($p>0.05$) in juiciness among the three fillers. The results showed that duck meatballs with higher moisture content tend to be juicie r.

Sensory evaluation of cooked duck meatballs: Overall, the sensory evaluation results showed no significant differences ($p>0.05$) among all of the sensory tests, except aroma. The result is shown no significant differences ($p>0.05$) for color. However, the color analysis using spectrophotometer still can detect differences among treatments especially for lightness. In the color system analysis, as the L* value of cassava (54.77) was found to be slightly lower than the L* value of corn (55.98). This means that the difference in the lightness is not affect the color acceptability of duck meatballs. The limited ability of human sensor toward the distinguishing color of duck meatballs may be other possible reason why the result of color acceptability shown no significant differences ($p>0.05$).

Taste was not significantly different ($p>0.05$) among corn, sago and cassava meatballs that were used in this study. However, the samples were acceptable to the panels (5.00 to 5.30 points on hedonic scale). Corn, sago and cassava are used in other products and the panelists are already familiar with the taste of these fillers, thus they are receptive to the taste of duck meatballs with those fillers. Memory has an important role during the sensory analysis in the product evaluation. As the tongue tastes something unusual, the taste is saved in the memory efficiently and will be remembered when the tongue tastes it again.

Although there were no significant differences ($p>0.05$) in taste among the fillers, the result showed a slight tendency for cassava. The slight differences in ash content in cooked duck meatballs influenced the taste of this product, which may be the result of salt that is added to the meatball mixture. The slightly higher ash percentage resulting from the use of cassava binders caused the duck meatballs to be saltier after heating and the panel tended to accept the product with the slightly higher salt amount in final duck meatballs.

During the chewing of food, there are changes of food properties both in physical and chemical of the food as the effects of saliva and the oral mucosa (Janssen *et al.,* 2009). The different results that occurred in the acceptability test of the duck meatballs were related to the homeostatic and hedonic systems in the brain of each panelist (Kringelbach, 2004). Experiences and food eating habits also affect the differences obtained during the test.

The aroma of duck meatballs was significantly stronger ($p<0.05$) in those prepared with the cassava as a filler, resulting in cassava being the preferred filler among the three tested. The meaty aroma of duck meatballs makes cassava the most preferable filler. The panelists preferred the slightly lower meaty aroma in duck meatballs. However, the meaty aroma was in the range of 4.8 to 5.4, which meant that the duck meatball with three different filler in this study was still accepted by the panelists. The total protein in the cooked product was slightly lower in meatballs prepared with cassava than the other fillers, which may be an objective factor leading to a lower score in the meaty aroma of cassava. The differences of final food composition after cooking may cause the differences in flavor forming reactions of sensory systems and cause the differences in aroma and flavor acceptances (Farmer, 1994).

Toughness and juiciness showed no significant differences ($p>0.05$) among the three fillers and the panelists' scores placed all fillers in the acceptable. The juiciness of meatballs prepared with cassava was slightly higher than the other duck meatballs. The juiciness of meatballs was due to its high moisture content. The moisture contents of the duck meatballs were 72.30% (cassava), 71.78% (sago) and 71.68% (corn) (Table 1).

Overall, the duck meatballs prepared with these three different fillers were acceptable for all treatments, suggesting that corn, cassava and sago can be used for duck meat processing. The selection of filler for duck meatballs on a bigger processing scale will be dependent on the price and availability of the filler in the market.

Conclusion: The fillers have no significant effects ($p>0.05$) on the duck meatballs, however, different stages of processing affects moisture and protein content. Almost all of the physicochemical properties are increased after preheating and heating. Sensory analyses showed that all fillers used in the duck meatballs are acceptable to the panelists.

ACKNOWLEDGEMENT

The authors acknowledge with gratitude the support given by Universiti Sains Malaysia (USM) and the Malaysian Ministry of Science, Technology and Innovation (MOSTI) through Science Fund research grant 05-01-05-SF0089.

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