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The improvement of nutrition quality and organoleptic characteristics of Indonesian milkfish meatball by adding kelor (*Moringa oleifera* Lam) leaves

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Abstract

The awareness on healthier foods has increased in the past decades. Therefore, the incorporation of healthier ingredients which are rich in phytochemicals beneficial for health is also drawing huge attention by food technologists worldwide. *Kelor* (*Moringa oleifera*) leaves are highly valued as food with high nutritional value, and regarded as supplement of protein and calcium besides containing phytochemicals, glucosinalates and isothyiocyanates. The aim of the present work was to improve the protein, calcium, and fibre contents and organoleptic characteristics of milkfish (*Chanos chanos*) meatballs. Organoleptic test, and protein, calcium and fibre content measurements were therefore conducted to evaluate the resulting milkfish meatballs with and without the addition of *kelor* leaves. Results obtained showed that the addition of *kelor* leaves increased calcium but decreased the protein content of milkfish meatballs. Boiled treatment reduced the protein content of milkfish meatballs but increased the fibre content. For all the organoleptic characteristics tested, original milkfish meatballs were more acceptable than samples with the addition of *kelor* leaves. Among the addition treatments for boiled and unboiled leaves, milkfish meatballs added with 10% boiled kelor leaves were the most accepted by panellists with colour, aroma, taste, texture, and overall acceptance scores of 2.65, 3.20, 2.88, 2.87 and 2.85, respectively. For future development and further investigation, it was henceforth suggested that the *kelor* leaves could be replaced with a mixture of tapioca flour and *kelor* leaves together with the addition of gelling agent which could further improve the texture of *kelor* milkfish meatballs.

Introduction

Indonesian meatballs, "*bakso*", are usually prepared from finely ground beef, chicken, pork or fish mixed with tapioca flour added with garlic, sodium tripolyphosphate and cooking salt. The most popular meatball among the Indonesians is beef meatball. Generally, the meatball batter is moulded into small- or medium-sized balls, and then boiled in water at 100°C for 20 minutes (Purnomo, 1999; Rahardiyan and McMillin, 2004; Purnomo and Rahardiyan, 2008). One of the meatball formula suggested by Fischer (1996) contained 53% lean beef, 17% fat and starch, phosphate, salt, monosodium glutamate and 30% ice cubes, while Rahardiyan (2002) reported that Indonesian meatballs are prepared traditionally by mixing thoroughly finely ground meat, cooking salt, starch and garlic.

The unique composition of milkfish (*Chanos chanos*; locally known as *ikan bandeng/bolu*) meat, such as high protein with essential amino acids and less stroma, renders the fish meat easily digestible. The high contents of unsaturated fatty acids (omega 3,6 and 9), minerals and vitamins renders the milkfish highly acceptable in Indonesia (Swastawati, 2004). Huda *et al.* (2010) also noted that milkfish meat contains high protein and carbohydrate while low in fat content. Therefore, milkfish is considered as an excellent source for nutritious food (such as fish meatballs) valuable for human health.

Fish meatballs or fish balls are usually prepared from finely ground fresh fish fillet or surimi, and mixed with cooking salt, garlic, tapioca starch and ice cubes. This mixture is then extruded into balls before boiling for 20 to 30 minutes depending on the ball size. In Indonesia, fish meatballs (locally known as *bakso ikan*) are mainly used as one of the ingredients in many Chinese cuisines. Fish meatballs are known as *bebola ikan* in Malaysia, vu huan among the Singaporean Chinese, nga soke in Myanmar, bola-bola in the Philippines, and look chin pa in Thailand (Kok, 2005). According to Agustini and Swastawati (2003) and Yap *et al.* (2007), milkfish surimi are

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made into some fish products such as fish balls, fish cakes, fish nuggets, fish burgers, fish patties and fish sausage. Agustini and Swastawati (2003) noted that the common Indonesian fishball formula is white fish meat (80-85%), starch (10-15%), cooking salt (2-3%), garlic (2%), white pepper (0.5%) and flavour enhancer (0.75%).

Bhat and Bhat (2011) noted that meat and meat products can be modified by incorporating non-meat ingredients such as protein, fat, and bioactive components of plant origins which have health benefits. Verma *et al.* (2016) reported that the incorporation of green cabbage (*Brassica oleracea*) could extent the shelf life of chicken meatballs besides improving its nutrition by integrating the bioactive components of green cabbage into the meat products. Furthermore, Verma *et al.* (2016) also noted that a need of healthier meat products has become crucial at present. Therefore, the incorporation of healthier ingredients such as oat, soy and other plant-based products which are rich in phytochemicals beneficial for health could also reduce the production cost, hence the increasing trend of plant proteins incorporation which is widely observed nowadays.

Kelor (*Moringa oleifera*) leaves are highly valued as food with high nutritional value and regarded as a supplement for protein, calcium and fibre besides containing phytochemicals, glucosinalates and isothyiocyanates with a multitude of health functions such as anti-hypertensive, anti-cancer and antimicrobial as reported by Evivie *et al.* (2015) and Leone *et al.* (2015). Results on the addition of *kelor* leaf powder into soy-based beef meatball at different levels showed that the samples were generally acceptable up to 2% of *kelor* leaf powder addition. However, meatballs without the addition of *kelor* leaf powder remained the most preferred (Evivie *et al.*, 2015).

It is therefore important to investigate the potentials of *kelor* leaves as natural source of nutrients to improve the nutritional quality and organoleptic properties of Indonesian milkfish meatballs. In the present work, *kelor* leaves were added either in fresh or cooked forms in the milkfish meatball batter.

Materials and methods

Preparation of milkfish fillet

Fresh milkfish samples (550-630 g weight, 30-32 cm length) were purchased from local market in Surabaya. Following purchase; the fish samples were immediately transported to the laboratory in polystyrene box with crushed ice. The fish samples were beheaded, gutted, filleted and thoroughly washed. The fillet was weighed according the formula, packed in polyethylene pouches, and frozen until further analysis.

Fresh and boiled kelor leaves

Matured *kelor* leaves were freshly plucked from the trees, weighed, thoroughly washed under running tap water, and equally divided into two portions; one portion was not treated (fresh; control) while the other was boiled for 2 min. Following boiling, the boiled *kelor* leaves were immersed in ice water for 2 min, and thoroughly rinsed to remove excess water.

Milkfish meatball preparation

The method of Basuki *et al.* (2012) with slight modification was followed in the preparation of milkfish meatballs. Briefly, the milkfish fillet (250 g) was mixed with 100 g tapioca flour, 50 g egg white, one table spoon of lime juice, 5 g stir-fried ginger slices, 5 g stir-fried garlic slices, one tea spoon white pepper powder, 5 g cooking salt, 10 g cane sugar, 20 mL frying oil, one table spoon limestone solution and fresh or boiled *kelor* leaves as treatment in the amount of 0 (no addition), 10, 15 and 20% (w/w), respectively. All ingredients were kneaded in a kitchen food processor for 5 min before forming balls with approximately 1 cm in diameter. The formed milkfish meatballs were boiled until fully cooked (floating). The cooked milkfish meatballs were drained and cooled off to ambient temperature before packed in polyethylene pouches and refrigerated until organoleptic test and laboratory analysis.

Organoleptic evaluation

Seven milkfish meatball samples of each treatment were randomly coded, and presented to 30 untrained panellists (who were mostly college students) to evaluate samples according to the degree of likeness in respect to taste, texture, colour and overall acceptance. The panellists were served with the samples and an evaluation form with a 5-point hedonic scale: “5” was “extremely like” and “1” was “extremely dislike” (Soekarto, 1985).

Protein content measurement

The SNI method No 01-2891-1992 point 7.1 (Kjeldahl method) was used to determine the protein contents of the milkfish meatball samples. Briefly, 0.51 g milkfish meatball sample was added with 2 g selenium and 25 mL H_2SO_4, and heated for 2 h. After cooled, it was diluted to 100 mL with distilled water. Next, 5 mL 30% NaOH and PP indicator was added to the sample and distillated for 10 min with 2% boric acid. The volume of HCl used to neutralise

Table 1. Protein, calcium and fibre contents (%) of milkfish meatballs with different additions of fresh and boiled kelor leaves.

Heat treatment	Kelor leaves addition (%)	Protein	Calcium	Fibre
Fresh	0	12.99 ± 0.19[aB]	11.09 ± 1.19[aA]	0.78 ± 0.06[aA]
	10	13.34 ± 0.82[aB]	65.33± 10.75[bA]	0.83± 0.02[aA]
	15	13.06 ± 0.35[aB]	79.45 ± 7.99[cA]	0.61 ± 0.17[aA]
	20	12.85 ± 0.11[aB]	95.26 ± 5.72[dA]	0.53 ± 0.18[aA]
Boiled	0	12.99 ± 0.19[aA]	11.09 ± 1.19[aA]	0.78 ± 0.06[aB]
	10	12.20± 0.32[aA]	45.18± 78.16[bA]	0.85± 0.06[aB]
	15	12.13 ± 0.33[aA]	89.52 ± 16.96[cA]	1.05 ± 0.08[aB]
	20	12.09 ± 0.52[aA]	97.82 ± 4.56[dA]	1.23 ± 0.06[aB]

The capital letters denote significant difference ($p < 0.05$) between the additions of kelor leaves. The small letters denote significant difference ($p < 0.05$) between fresh and boiled leaves. Data are means of triplicates ($n = 3$) ± SD.

the sample was measured to determine the nitrogen percentage. The protein content was calculated by multiplying the nitrogen percentage with 6.25.

Calcium content measurement

The calcium content was measured by following the AOAC (2005) (AAS) method. Briefly, the milkfish meatball samples were destroyed by dry ashing. The remaining ash was dissolved by 1% $LaCl_3$. The calcium content was determined by atomic absorption spectrophotometry.

Fibre content measurement

The fibre content was measured by following the SNI 01-2891-1992 point 11 (gravimetric) method. Briefly, the milkfish meatball sample was macerated and stirred in 96% ethanol to reduce the fat, and then dried. Next, 50 mL 1.25% sulfuric acid was added, and the solution was heated for 30 min, following which, 50 mL 3.25% sodium hydroxide was then added, and the solution was re-heated for another 30 min. The sample was filtrated and washed by 1.25% sulfuric acid, hot water and 96% ethanol. The filtrate was then dried at 105°C until stable weight was achieved, and the fibre content was measured.

Experimental design and statistical analysis

The present work was conducted using Randomised Block Design (RBD) with two treatments (fresh and boiled *kelor* leaves at 0%, 10%, 15% and 20% w/w), and the data obtained were analysed by using the Analysis of Variance (ANOVA) using Microsoft Excel 2010. $p < 0.05$ was accepted as significant difference followed by Duncan's Multiple Range Test (Gomez, 1984).

Results and discussion

The protein, calcium and fibre contents of the milkfish meatball samples added with either fresh or boiled *kelor* leaves are presented in Table 1. There was no significant effect ($p > 0.05$) between the addition of fresh or boiled *kelor* leaves. However, fresh *kelor* leaves showed a significant increase ($p < 0.05$). in protein content as compared to boiled *kelor* leaves. The protein content of original milkfish meatball was 12.99%, while Kathryn (2013) reported that the protein content of fresh *kelor* leaves was 8.8% (w/w). Therefore, the addition of *kelor* leaves actually reduced the protein content of the milkfish meatball. Based on the results in Table 1, it is therefore suggested to substitute the *kelor* leaves with tapioca flour instead of adding the leaves to the milkfish batter. In samples added with boiled *kelor* leaves, the protein content decreased due to the heat treatment on the leaves. Alakali *et al.* (2015) reported that the increase in temperature corresponded to the increase in protein denaturation thus resulting in significant decrease in protein content as observed in the present work.

Leone *et al.* (2015) reported that the predominant mineral in *kelor* leaves was calcium (1,839.10-2,743.38 mg/100 g). The addition of *kelor* leaves significantly ($p < 0.05$) increased the calcium contents of the resulting milkfish meatballs but did not increase the fibre contents. When adding the boiled *kelor* leaves, crude fibre contents of the milkfish meatball samples increased and significantly differed ($p < 0.05$) from the fresh *kelor* leaves. Rathnayake and Navarathna (2015) reported that blanched *kelor* leaves had higher fibre contents than unblanched leaves. Since calcium is important in the formation and maintenance of bones and teeth, the addition of *kelor* to milkfish meatballs could improve the dietary intake of calcium.

Table 2. Organoleptic test results for milkfish meatballs with different additions of fresh and boiled kelor leaves.

Heat treatment	Kelor leaves addition (%)	Colour	Aroma	Taste	Texture	Overall acceptance
Fresh	0	4.01 ± 0.05^{bA}	3.91 ± 0.05^{cA}	3.31 ± 0.17^{bA}	3.12 ± 0.45^{bA}	3.57 ± 0.12^{bA}
	10	2.42 ± 0.40^{aA}	2.6 ± 0.35^{abA}	2.26 ± 0.26^{aA}	2.37 ± 0.36^{abA}	2.45 ± 0.35^{aA}
	15	2.50 ± 0.34^{aA}	2.91 ± 0.53^{abA}	2.41 ± 0.30^{aA}	2.48 ± 0.49^{bA}	2.60 ± 0.38^{aA}
	20	2.23 ± 0.07^{aA}	2.55 ± 0.25^{aA}	2.24 ± 0.24^{aA}	2.29 ± 0.45^{aA}	2.38 ± 0.24^{aA}
Boiled	0	4.01 ± 0.05^{bA}	3.91 ± 0.05^{cB}	3.31 ± 0.17^{bB}	3.12 ± 0.45^{bA}	3.57 ± 0.12^{bA}
	10	2.65 ± 0.07^{aA}	3.20 ± 0.21^{abB}	2.88 ± 0.18^{aB}	2.87 ± 0.33^{abA}	2.85 ± 0.36^{aA}
	15	2.45 ± 0.14^{aA}	2.97 ± 0.29^{abB}	2.79 ± 0.57^{aB}	2.81 ± 0.34^{bA}	2.83 ± 0.41^{aA}
	20	2.49 ± 0.09^{aA}	3.03 ± 0.20^{aB}	2.72 ± 0.44^{aB}	2.81 ± 0.45^{aA}	2.76 ± 0.48^{aA}

The capital letters denote significant difference ($p < 0.05$) between the additions of kelor leaves. The small letters denote significant difference ($p < 0.05$) between fresh and boiled leaves. Data are means of triplicates ($n = 3$) ± SD.

The acceptance results of milkfish meatball samples added either with fresh or boiled *kelor* leaves are presented in Table 2. The colour of the milkfish meatball samples without the addition of *kelor* leaves was more preferred over the samples added with either fresh or boiled *kelor* leaves. Boles and Pegg (2005) noted that colour has been identified as the single most important factor that influences consumers' buying decision, and affects their perception of freshness of the product. The addition of *kelor* leaves caused the colour of the milkfish meatball samples to turn green. According to Wibowo (1999), consumers' perception for colour of meatball is light brown with a little bit red or light brown with a little bit grey. Therefore, it can be said that the green colour of the milkfish meatball samples in the present work was not desirable.

Based on the results, untrained panellists would rather smell and taste the milkfish meatball samples without the addition of *kelor* leaves. Penaflorida and Masbano (2015) reported that aroma and taste acceptance of mango puree enriched with *kelor* leaves decreased with increasing leaf ratio. A similar report was also made by Nambiar and Parnami (2008) on the substitution of *kelor* leaves which imparted leafy flavour. The *kelor* leaves are known to contain polyphenols which are bitter to taste. This slightly bitter taste of *kelor* leaves might have caused the panellists to comment that the milkfish meatball samples with the addition of *kelor* leaves had a strange aroma and taste. Gernah *et al.* (2012) reported that heat treatment could reduce the phenol contents in *kelor* leaves. As evident from the results, boiled *kelor* leaves had significantly ($p < 0.05$) higher acceptability in aroma and taste of the milkfish meatball samples, which in turn might indicate that the decrease in phenol contents had decreased the bitter taste of the milkfish meatball samples. Therefore, a further investigation on how to mask the bitter leafy taste is urgently needed. According to Rofiah (2015), ginger (Zingiber officinale) and galangal (Alpinia galangal) could mask the bitter leafy taste of *kelor* leaves tea. Rahmawati and Adi (2011) reported that lemon could also be used to mask the bitter leafy taste of *kelor* in jelly preparation. Furthermore, the addition of hydrocolloids might also modify the perception and release compound of flavour as noted by Troszynska *et al.* (2008) which reported that the addition carboxymethyl cellulose (CMC) could mask the astringency of polyphenols.

Texture is one important factor in meatball. Meatball that is too soft will decrease the preference of consumers, as well as meatball that is too chewy (Suprapti, 2003). In the present work, the texture of the original milkfish meatball samples was more desired than those added with either fresh or boiled *kelor* leaves. Panellists commented that the texture of milkfish meatball samples with the addition of *kelor* leaves was too soft. Minerva (2013) reported that the addition of *kelor* leaves reduced the starch content in crackers made by mixing *suweg* flour and *kelor* flour. The addition of *kelor* leaves decreased the chewiness of the milkfish meatball samples because the content of the starch also decreased. According to Zakaria *et al.* (2010) and Soltanizadeh and Esfahani (2015), gelling agent could be added to improve the texture of meatball, such as carrageenan or *aloe vera*.

Fresh and boiled treatments and the concentrations added was not significantly different ($p > 0.05$) in overall acceptance of *kelor* milkfish meatball samples. Overall, panellists still preferred the original milkfish meatballs. The overall acceptance score of *kelor* milkfish meatball samples was below than 3 which indicated neutrality in preference.

Nevertheless, although the results obtained in the present work was less than satisfactory, the investigation on *kelor* leaves towards novel food application should not be hindered. *Kelor* is one of the richest plant sources of vitamins A, B, C, D, E and K. The vital minerals present in *kelor* include calcium, copper, iron, potassium, magnesium, manganese and zinc, and contain more than 40 natural antioxidants. *Kelor* also contains all the essential amino acids which are the building blocks of proteins (Mahmood *et al.*, 2010). The benefit of *kelor* leaves should be promoted to change consumer perception, because consumers' knowledge does affect the consumers' perception towards a product (Bonfanti and Brunetti, 2015).

Conclusion

The addition of *kelor* leaves increased the calcium content in the milkfish meatball samples but decreased the protein content. Boiled *kelor* leaves increased the crude fibre content of the milkfish meatballs. The addition of 10% until 20% *kelor* leaves did not significantly affect the colour, flavour and overall acceptance, but significantly affected the aroma and texture of the milkfish meatball samples. Boiling decreased the protein content, but increased the aroma and flavour acceptance significantly. The colour, texture and overall acceptance were not significantly different between 10% and 20% addition of *kelor* leaves. The results also showed that milkfish meatballs added with 10% boiled *kelor* leaves was the most accepted by the panellists with score of colour, aroma, taste, texture and overall acceptance of 2.65, 3.20, 2.88, 2.87, and 2.85, respectively. For all parameters of sensory acceptance, the original milkfish meatballs were still more acceptable and preferred. The benefits of *kelor* leaves should be further promoted to change the consumers' perception because consumers' knowledge does affect the consumers' perception towards a product. For future development and further investigation, it was henceforth suggested that the *kelor* leaves could be replaced with a mixture of tapioca flour and *kelor* leaves together with the addition of gelling agent which could further improve the texture of *kelor* milkfish meatballs.

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