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Development of formulations for meat pickle

(Pembangunan formulasi acar daging)

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Abstract

Meat pickles or *acar daging* is a dish of preserved meat that is used as a side dish. The method of food preservation is to pickle the meat in acetic acid which will influence the physical and chemical properties of the pickles. This study evaluated the physical and chemical properties of meat pickles processed using three different formulations with different levels of acetic acid, namely, 20% (A), 30% (B) and 40% (C). Use of acetic acid substantially brought down the pH of pickles and results showed that the pH ranged from 4.04 to 4.17. The proximate analysis showed that the meat pickles were high in protein with crude protein content ranging from 12.44 to 13.22 g/100 g. Colour evaluation indicated that there was no significant difference between the colour (L*, a*, b* values) of the meat preserved at the different levels of acetic acid. Meat samples preserved in 40% acetic acid had the lowest hardness value and was significantly different (p <0.05) from the other samples. The sensory evaluation showed that meat preserved in 30% acetic acid was preferred followed by those preserved in 20% and 40% acetic acid. Microbiological counts did not show substantial change and remained satisfactory throughout the 3 months storage period. Therefore, it can be concluded that the meat pickle can safely be stored on the shelf for 3 months.

Introduction

Meat pickles are ready to eat, convenient meat products with good shelf stability at ambient temperature (Arun et al. 2007). Gadekar et al. (2010) stated that the pickling of meat offers highly delicious and nutritious ready to eat shelf stable product with relatively better shelf life. High perishability of meat and meat products is a serious problem in tropical countries. The high perishability is due to the suitable environment for proliferation of meat spoilage microorganisms and common food-borne pathogens. Therefore, such products require considerable input for chilling or freezing during storage and marketing. However, this kind of meat preservation either in fresh or processed forms requires considerable energy. Pickling of meat is an alternative method to develop a low cost shelf stable meat product in the market. Therefore, it can provide a better avenue for rural entrepreneurship development (Gadekar et al. 2010). Pickling also helps in improving desirable characteristics like taste, flavour and texture along with preservative effect. Acetic acid also improves the meat texture making it more digestible.

Low water activity (a_w) and pH are the two major barriers that contribute to shelf stability of pickled food (Gadekar et al. 2010). Acidified products may limit

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microbial growth or survival depending on the types of microorganisms harboured in the food and the type and amount of acid used. Rhee et al. (2003) reported that the addition of a small amount of acetic acid (0.5%) to mustard can retard the growth of *Escherichia coli* 0157:H7 and *Listeria monocytogenes*. An 'acidified' food is defined as a low acid food which has a maximum pH of 4.6 or less and a water activity greater than 0.85. These may be called 'pickle' or 'pickled food' (Food Processor Institute 1998).

Acidification of food to pH ≤ 4.6 is intended to prevent the growth of microorganisms and make the product shelf stable at room temperature (Food Processor Institute 1998). The growth of *Clostridium botulinum* can be prevented as its spores do not grow below pH 4.6 or at water activity below 0.94 (Solomon and Kautter1988). The pickling of meat through acidification has been studied worldwide (Arun et al. 2007; Gadekar et al. 2010; Malik and Sharma 2011). Arun et al. (2007) reported that the pH of meat pickles ranged from 4.4 to 4.7. They also reported that the pickle can be safely stored on the shelf for 60 days even during summer season. Gadekar et al. (2010) studied the shelf stability of chicken, quails, gizzard, mutton, pork, buffalo and rabbit pickles and they reported the reduction in microbial count due to pickling.

The objective of this study was to establish formulations of meat pickle and investigate the effects of processing on the physico-chemical characteristics, microbiological qualities as well as the acceptance of buffalo meat pickle.

Materials and methods

Processing method

The buffalo meat (top side) was purchased from Sarborn Freshmart Sdn Bhd while spices were purchased from Giant Hypermarket, Kajang. The meat samples were sliced using a band saw, cut into cubes (1 cm x 1 cm x 1 cm) and soaked in vinegar (4% acetic acid) in an air tight container for 12 h at 5 °C. After soaking, the samples were boiled at a constant boiling time and temperature (60 °C for 180 min) as recommended by Bertola et al. (1994). The samples were then mixed with 4% acetic acid, spices, sugar, salt and chillies, and cooked for 2 h. The spices used were mustard seed (*Brassica juncea*), fenugreek (*Trigonella foenum-graecum*), black cumin (*Nigella sativa*) and cumin (*Cuminum cyminum*). The mixture of dry spices and condiments used in the pickle preparation is presented in *Table 1*. Three types of meat pickles were formulated using different levels of ingredients and acetic acid [20% (A), 30% (B) and 40% (C)]. The meat pickles (150g meat portion and 50 g liquid portion) were hot-filled (80 °C) into 200 ml air tight glass jars and pasteurised (95 °C) for 35 min. Finally, the pickles were stored at room temperature (26 °C) for about a week for further analysis.

Table 1. The mixture of dry spices and condiments used in pickle preparation (%)

Formulations	A	B	C
Meat	30.00	30.00	30.00
Water	29.20	19.20	9.20
*Acetic acid	20.00	30.00	40.00
Sugar	15.50	15.50	15.50
Cooking oil	2.15	2.15	2.15
Chillies	0.60	0.60	0.60
Salt	0.50	0.50	0.50
Onion	1.50	1.50	1.50
Mustard seed	0.20	0.20	0.20
Fenugreek	0.15	0.15	0.15
Black cumin	0.10	0.10	0.10
Cumin	0.10	0.10	0.10
Total	100	100	100

*Used in pickle (%)

Determination of pH, water activity, brix and titratable acidity

The pH values of meat pickles at different stages of pickling (raw, soaked, pickled) together with the liquid portion were determined by homogenizing 10 g of each sample with 100 ml distilled water. The pH was recorded with a digital pH meter (Mettler Toledo δ-320, Shanghai).

The Aqua Lab Series 3 (Aqualab, Labcell, Basingstoke) was used to measure water activity of the samples at 25 °C. The refractometer (range: 28° – 62°) was used to measure the brix values. The samples were homogenized prior to analysis and measurements were done in triplicate. Titratable acidity of the samples was evaluated using Autotitrator (Autotitrator Mettler DL 50, Schwerbach, Swistzerland) according to the method described by Hasimah et al. (2009). About 10 ml aliquots were titrated against 0.01N NaOH in the burette using 0.1% phenolphthalein solution as indicator. The volume of 0.01N NaOH per g of sample utilised was expressed as titratable acidity.

Sensory evaluation

The meat pickles were evaluated by 25 trained sensory panellists. The training session was started with a screening test that taught the candidates the test process while weeding out unsuitable non-discriminators. The screening tests determined suitable candidates with the ability to discriminate the different levels of intensity for each attribute. The sensory evaluation was conducted in individual booths, in a standard taste panel kitchen. The evaluation was done using a 9-point hedonic rating scale ranging from 1 to 9 where 9 represented the highest score. The meat pickles were evaluated for colour, aroma, sourness, sweetness, texture, taste and overall acceptability according to the method described by Meilgaard et al. (1991).

Proximate composition

The protein, moisture, fat and crude fibre contents of the meat pickles were analysed in duplicate using the standard AOAC (2000) method.

Colour determination

The colour of the meat pickles and the liquid portion were measured with Minolta chroma meter (Minolta CR-300, Japan) after the products were cut into cubes (0.5 cm x 0.5 cm x 0.5 cm). The instrument was calibrated using the white calibration plate (CR-A43) before analysis. The colour was determined by measuring the L*, a* and b* values of each sample. The Judd-Hunter Lab solid represents the colour spectrum in which L* measures lightness or darkness, a* red to green and b* yellow to blue.

Texture profile analysis

The texture profile of the meat pickles was determined using a texture analyser (Model $TA\text{-}HD_{plus}$ Texture Technologies, Surrey, UK) with Texture Expert Exceed software version 2.54a (Texture Technologies, Surrey, UK). The samples were evaluated for hardness, springiness, cohesiveness, chewiness and resilience. The analysis was done at temperature using a two-cycle compression probe (P/36R). Both the pre-test and post-test speeds of the probe were set at 5 mm/s. The strain was set at 50% using a 50 kg load cell. The acquisition rate was set at 100 pps.

Microbiological analysis

For microbiological analysis, the meat pickles were stored at room temperature for 6 months. Samples were taken at 0, 3 and 6 months for the analysis which included the total plate count, yeast, mould, coliform, acetic acid bacteria and lactic acid bacteria. The analysis was conducted according to the method of APHA (2001).

Statistical analysis

The experiment was conducted using a completely randomized design with three replications for each treatment, namely, 20% (A), 30% (B) and 40% (C) acetic acid. The data were analysed statistically using Analysis Of Variance (ANOVA) and mean values were evaluated by Duncan Multiple Range Test (DMRT) using SPSS 12.0 software program. The p values ≤0.05 were regarded as significant.

Results and discussion

The changes in pH during various stages of buffalo meat pickling process (raw, soaked, pickled) are shown in *Figure 1*. The pH value of the raw meat ranged from 5.67 to 5.79 and this is in agreement with the pH value reported by Neath et al. (2007). The pH of the raw meat falls rapidly after acidic immersion using 4% acetic acid in formulations A (20%), B (30%) and C (40%) to pH values 3.94, 3.88 and 3.80 respectively. This fall in pH is due to the acetic acid absorption into the meat muscle through capillary forces by pressure gradient exerted by internal deformation of the meat (Gault 1985). However, the pH value of the final products for formulations (A), (B) and (C) increased to 4.17, 4.07 and 4.04 respectively, as shown in *Figure 1*. The slight increase in pH was due to the dilution of the meat pickle during processing. The pH of the liquid portion was slightly lower than the pickled meat portion, ranging from 3.93 to 4.12.

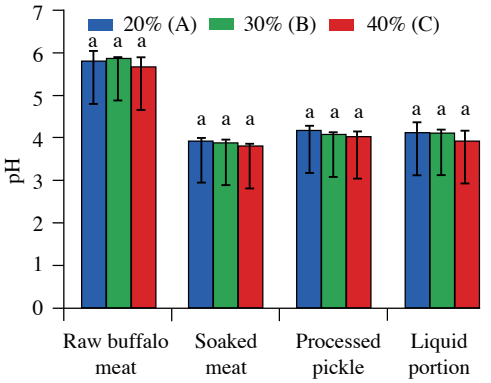

Figure 1. pH changes during various stages of buffalo meat pickling process; raw meat, soaked meat, processed meat and liquid portion during processing with 20% (A), 30% (B) and 40% (C) acetic acid. Values shown are mean ± standard deviation of triplicate measurements. Means with same letter are not significantly different at 5% level (p <0.05)

The water activity of the meat pickle ranged from 0.94 a_w to 0.95 a_w (*Table 2*). Any food that has water activity (a_w) greater than 0.85 and a finished equilibrium pH of 4.6 or below can be categorised as "pickles" or "pickled" food (Barron 2007). The brix values of formulations B (30%) and C (40%) were significantly ($p \leq 0.05$) lower than formulation A (20%). This was due to the reduction of solutes into the meat in a more acidic environment as reported by Goli et al. (2011). There was significant difference ($p \leq 0.05$) in the concentration of total titratable acidity between formulations A (20%) and the other formulations. This difference was due to the critical concentration of the acetic acid used. Similar observation was made by Sahu et al. (2012) who reported a significant difference in

Table 2. The water activity, brix values and total titratable acidity of meat pickles with 20% (A), 30% (B) and 40% (C) acetic acid

Sample	20% (A)	30% (B)	40% (C)
Water activity	0.946 ± 0.03a	0.946 ± 0.02a	0.937 ± 0.01a
Brix	60.20 ± 13.01b	49.33 ± 3.51a	40.00 ± 14.14a
Total acidity (g/100g) acetic acid	1.83 ± 0.05b	2.06 ± 0.17a	2.41 ± 0.23a

Values shown are mean ± standard deviation of triplicate measurements. Significant differences within row (p <0.05) are expressed by different letters

titratable acidity of Murrel (*Channa striatus*) fish pickle when preserved in 1% acetic acid compared to those preserved in 0.85% acetic acid.

Sensory evaluation showed that meat pickle preserved in 30% (B) acetic acid was preferred by the taste panellists compared to samples preserved in 20% (A) and 40% (C) acetic acid (*Figure 2*). In general meat pickle preserved in 30% acetic acid obtained higher scores in all attributes. The analysis showed that the panellists gave the highest score of 6.3 to sample B (30%) followed by sample C (40%) and A (20%) for overall acceptability. Similarly, sample B was also given the highest score (5.96) for sourness compared to samples C and A. This showed that panellists preferred the intermediate sourness of buffalo pickles.

The protein content of the meat pickles ranged from 12.44 to 13.22 g/100 g on wet basis (*Table 3*). This showed that the buffalo meat pickles were high in protein. The high protein content of meat pickles was also reported by Maiti et al. (2009). The moisture content, ash, fat, dietary fibre and carbohydrate showed no significant difference (p <0.05) between samples preserved in 20, 30 or 40% acetic acid. These results were in accordance with Maiti et al. (2009) who reported that pickling had no significant effect on proximate composition of chicken gizzard and goat heart.

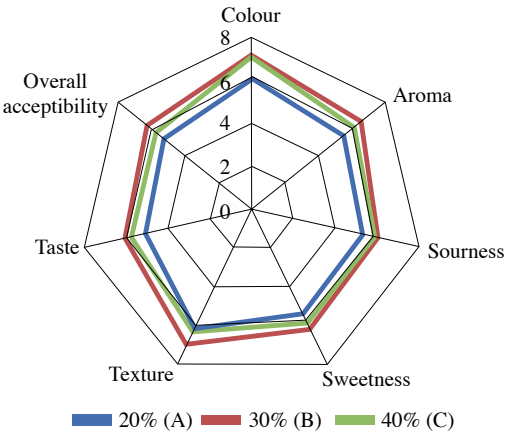

Figure 2. Spider web of sensory evaluation of meat pickles

Statistical analysis showed that there was no significant difference (p <0.05) in the colour of the meat preserved in different levels of acetic acid as shown by the L*, a* and b* values (*Table 4*). This is in agreement with the sensory evaluation test where the panellists gave same colour score for all meat pickles.

The texture profile analysis is shown in *Figure 3*. Meat pickle which was preserved in 40% vinegar had the lowest hardness value and was significantly different (p <0.05) from the other samples. This may be due to the influence of acetic acid on the muscle fibre during acidification process that caused proteolytic breakdown of muscle proteins (Rao and Gault 1990; Saunders 1994). No significant difference (p >0.05) was observed for springiness, cohesiveness, chewiness and resilience between the different formulations.

The total plate count, yeast, mould, coliforms, acetic acid bacteria and lactic acid bacteria are shown in *Table 5*. No microbial growth was detected for products

Table 3. Proximate composition of buffalo meat pickles with 20% (A), 30% (B) and 40% (C) acetic acid (g/100 g)

Sample	Moisture	Crude protein	Ash	Fat	Dietary fibre	Carbohydrates
20% (A)	50.57 ± 0.02a	12.44 ± 0.04a	1.40 ± 0.23a	3.50 ± 0.11a	2.70 ± 0.02a	32.09 ± 0.05a
30% (B)	53.15 ± 0.04a	12.86 ± 0.03a	1.12 ± 0.15a	7.57 ± 0.16a	2.38 ± 0.05a	25.30 ± 0.07a
40% (C)	55.28 ± 0.07a	13.22 ± 0.13a	1.26 ± 0.17a	5.24 ± 0.14a	2.67 ± 0.03a	25.00 ± 0.02a

Values shown are mean ± standard deviation of triplicate measurements. Different letters in the same column denote statistical difference (p <0.05) between treatments

Table 4. Colour evaluation (L*, a*, b* values) of meat pickles with 20% (A), 30% (B) and 40% (C) acetic acid

Samples	Colour values	20% (A)	30% (B)	40% (C)
Meat portion	L*	25.30 ± 5.08a	27.04 ± 3.78a	27.86 ± 3.39a
	a*	+6.83 ± 1.12a	+8.50 ± 0.80a	+8.85 ± 3.13a
	b*	+6.90 ± 4.72a	+7.74 ± 2.29a	+7.00 ± 2.30a
Liquid portion	L*	44.64 ± 18.32a	38.52 ± 17.77a	45.32 ± 19.94a
	a*	+11.44 ± 4.07a	+14.90 ± 6.87a	+11.80 ± 0.59a
	b*	+17.67 ± 15.39a	+12.46 ± 10.14a	+17.59 ± 15.26a

Values shown are mean values ± standard deviation of triplicate measurements. Different letters in the same row denote statistical difference (p <0.05) between treatments

Table 5. Microbiological analysis of meat pickles with 20% (A), 30% (B) and 40% (C) acetic acid

Sample	Months	Total plate count (cfu/g)	Yeast and mould (cfu/g)	Coliforms (cfu/g)	Lactic acid bacteria (cfu/g)
20% (A)	0	< 1x10	< 1x10	< 3	< 1x10
	3	< 1x10	< 1x10	< 3	< 1x10
	6	< 1x10	< 1x10	< 3	< 1x10
30% (B)	0	< 1x10	< 1x10	< 3	< 1x10
	3	< 1x10	< 1x10	< 3	< 1x10
	6	< 1x10	< 1x10	< 3	< 1x10
40% (C)	0	< 1x10	< 1x10	< 3	< 1x10
	3	< 1x10	< 1x10	< 3	< 1x10
	6	< 1x10	< 1x10	< 3	< 1x10

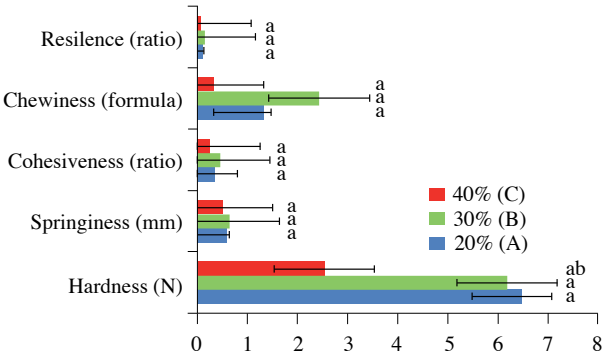

Figure 3. Texture profile of meat pickles preserved with 20% (A), 30% (B) and 40% (C) acetic acid. Values shown are mean ± standard deviation of triplicate measurements. Means with the same letter are not significantly different at 5% level (p <0.05)

stored for 3 months storage period. Similar observations were made by Das et al. (2013) on meat pickle prepared from spent chicken. They reported that meat pickle could be shelf-stable up to 3 months at ambient temperature. This may be due to the heat treatment and acetic acid used for pickling which retards the microbial growth. Acetic acid and heat are considered as major factors for increasing microbial safety of pickled products (Young Lee 2004). In addition, the pasteurisation performed after bottling also increases the microbiological safety of the product (Lu-qin et al. 2009).

Conclusion

It can be concluded that pickling of buffalo meat produced acceptable products that were shelf-stable and can be safely stored for 90 days at ambient temperature. Sensory evaluation showed that meat pickle preserved in 30% acetic acid was the most acceptable formulation compared to pickles preserved in 20% and 40% acetic acid. Due to lower initial cost of investment and non-requirement of refrigeration facility, the meat pickle has good potential to be developed by the rural entrepreneurs.

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Abstrak

Acar daging ialah daging yang diawet untuk dijadikan hidangan sampingan. Kaedah pengawetan yang digunakan ialah menjeruk daging tersebut di dalam asid asetik yang akan mempengaruhi sifat fizikal dan kimia acar daging tersebut. Kajian ini menilai sifat-sifat fizikal dan kimia acar daging yang diproses menggunakan tiga formulasi dengan tahap asid asetik yang berbeza iaitu 20% (A), 30% (B) dan 40% (C). Penggunaan asid asetik didapati menurunkan pH acar daging dan keputusan menunjukkan bahawa pH acar daging ialah 4.04 sehingga 4.17. Analisis proksimat menunjukkan bahawa acar daging mengandungi kandungan protein yang tinggi dengan kandungan protein kasar sebanyak 12.44 – 13.22 g/100 g. Penilaian warna menunjukkan bahawa tidak terdapat perbezaan yang signifikan pada warna daging yang diawet dengan kandungan asid asetik yang berbeza. Sampel daging yang diawet dalam 40% asid asetik menunjukkan nilai kekerasan paling rendah secara signifikan (p <0.05) berbanding dengan sampel yang lain. Analisis deria menunjukan bahawa daging yang diawet dengan 30% (B) asid asetik paling disukai berbanding dengan sampel yang diawet dengan 20% (A) dan 40% (C) asid asetik. Ujian mikrobiologi tidak menunjukkan perubahan ketara dan kekal memuaskan sepanjang 3 bulan tempoh penyimpanan. Oleh itu, dapat disimpulkan bahawa acar daging selamat boleh disimpan di atas rak selama 3 bulan.

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