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Product Development of Crocodile Jerky

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ABSTRACT

Crocodile jerky was developed from freshwater crocodile (*Crocodylus siamensis*) tail meat. The Ratio Profile Test (RPT) was used to find the most acceptable product. Seasonings (soy sauce, sugar, and pepper) and processing conditions (drying time and temperature, frying time and temperature) were varied. The jerky sample with 8 % soy sauce, 6.5 % sugar, 2.5 % pepper and 3 % white sesame seed, dried at 60°C for 2 hours and fried at 160°C for 1 minute received the highest acceptability score ($P \leq 0.05$). The shear force, L*, a*, b* values and a_w of the prepared product were 25.8 N., 41.5, 5.3, 9.4 and 0.63, respectively. The proximate composition of the fresh meat was 72.3 % moisture, 20.2 % protein, 5.5 % fat, 1.0 % ash and 0.9 % carbohydrates, and the total viable bacterial count was 1.48×10^6 CFU/g. The proximate composition of the jerky was 13.9 % moisture, 48.2 % protein, 14.7 % fat, 5.3 % ash and 17.9 % carbohydrates. No microorganism was found in the jerky. The product shelf life was determined according to the thiobarbituric acid number set at 2.5 mg malonaldehyde/Kg by accelerated temperature test. The product was stored in aluminum foil laminated plastic (OPP/LDPE/Al/LDPE/OPP) bags at ambient temperature (30±3°C) under different conditions. The results showed that shelf life was 7 weeks when packed under air, 9 weeks under air with moisture absorber, 14 weeks under air with oxygen absorber and 13 weeks under modified atmosphere of 100 % nitrogen.

Key words: crocodile meat, crocodile jerky

INTRODUCTION

Freshwater, marine and hybrid crocodiles are farm-raised successfully in Thailand. The most commonly bred species is the freshwater crocodile (*Crocodylus siamensis*). At present, the number of crocodile farms is increasing. The main purpose of farming is to produce and export crocodile leather products. Crocodile meat, especially from the tail part, is believed to be a nutraceutical and can be cooked with herbs to cure asthma (Maneenopphol, 1998). It is popular among Chinese, Taiwanese, and Korean tourists. Furthermore, canned stew, soup and dried crocodile meat have been processed. In Australia, there are many kinds of crocodile products such as burgers and jerky (Rattanakorn, 1994). Jerky is a product rather similar to Thai semi-dried beef or pork. Since it is light-weight and shelf-stable, making crocodile jerky with a Thai-style taste and flavor might expand the uses of crocodile meat. Therefore, the objectives of this study are as follows:

1. To determine the proximate composition of fresh crocodile meat and prepared crocodile jerky.

2. To develop a process for Thai-style

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crocodile jerky.

3. To set up the thiobarbituric acid (TBA) number as a quality index for the prepared crocodile jerky.

4. To find the shelf life of the prepared crocodile jerky under different storage conditions at ambient temperature.

MATERIALS AND METHODS

Process development of crocodile jerky

Frozen crocodile meat was sliced into thin sheets of approximately 3 × 6 × 0.5 cm and marinated with seasonings at 4-6°C for 16 hours before drying. The dried product was fried at 160° C for 1 minute.

The Ratio Profile Test (RPT) of product using soy sauce (6.0 %), sugar (4.5 %), ground pepper (1.5 %) and sesame seeds (3.0 %) as in semi-dried catfish sticks (Department of Fishery Products, 2000) was conducted. The marinated crocodile meat was dried at 60°C for 3 hours then fried at 160°C for 1 minute. Sensory evaluation by 10-trained panelists for color, spice odor, hardness, toughness, sweetness, saltiness and aftertaste was carried out.

To develop the most acceptable product, appropriate amounts of seasoning and spice were studied by varying one factor at a time. The variables were soy sauce (8, 8.5 and 9.0 % w/w of crocodile meat); sugar (5.0, 6.5 and 8.0 % w/w) and pepper (1.5, 2.0 and 2.5 % w/w). The prepared samples were sensory evaluated by 30 panelists for appearance, color, odor, taste, texture and overall acceptability using a 9-point hedonic scale (1 = dislike extremely and 9 = like extremely). The experimental design used was a randomized completely block design. The scores were statistically analyzed for ANOVA, and Duncan's new multiple range tests were employed for comparison among sample means.

Optimal drying temperature and time of product with the highest acceptability score were determined at 50 and 60°C for 1.5 and 2 hours. The experimental design was 2×2 factorial. The samples were sensory evaluated as above.

Quality of crocodile jerky

Shear force of the prepared crocodile jerky with the highest acceptability score was measured with the TA-HD Texture Analyzer. L*, a* and b* were measured by the Minolta CM-3500. a_w was measured with a Thermoconstanter Novasina TH 200.

Proximate compositions of fresh crocodile meat and crocodile jerky were analyzed according to AOAC (1984).

Total viable bacterial and Salmonella counts were determined according to FDA (1984).

Deterioration at an accelerated temperature

The prepared crocodile jerky was placed on a glass plate with a cover and stored at 50°C. Samples were taken for the TBA number analysis (Woods and Aurand, 1977; Shibata and Kinumaki, 1979) and the rancid odor was determined by 5 trained panelists every day. The TBA number at the point that rancidity could be detected by the panelists was considered as the end of storage time.

Shelflife

Samples (20 g each) of prepared crocodile jerky were packed in 12 × 18 cm aluminum foil laminated plastic bags (OPP/PE/Al/PE/OPP of 20/25/7/20/30 microns thickness) and stored at ambient temperature (30±3°C) under different conditions namely: air, air with a moisture absorber bag (silica gel), air with an oxygen absorber bag (ferric) and modified atmosphere of 100 % nitrogen.

Samples were taken once a week for the TBA number analysis until TBA number exceeded the predetermined value. The experimental design was a split plot with packaging conditions as a main plot and storage time as a subplot.

RESULTS AND DISCUSSION

Process development of crocodile jerky

RPT results are shown in Table 1. The ratios of ideal and sample scores on toughness and hardness were higher than 1.0, but those of spice odor, sweetness and saltiness were lower than 1.0. Therefore, drying time and temperature, amount of spice and seasonings were adjusted in the next step.

Sensory evaluation of samples prepared with varying amounts of soy sauce, sugar and pepper contents are shown in Tables 2-4. It may be concluded that the appropriate amounts of soy sauce, sugar and pepper were 8, 6.5 and 2.5% by weight of the crocodile meat, respectively.

It was found that drying time and temperature significantly affected the texture of the product ($P \leq 0.05$). Shear force of products dried at 50 and 60°C is shown in Table 5. Sensory evaluation of samples is shown in Table 6. The sample dried at 60°C for 2 hours received the highest sensory score for texture with the highest shear force. The appearance, color and overall acceptability scores were the highest as well.

It was recommended that jerky with the size of $12.5 \times 5 \times 0.6$ cm should be dried at a temperature between 60 and 65°C for at least 4 h to keep it from spoiling (http://www.alljerky.com/wwwboard/wwwboard.html). The size of samples in this study were smaller, thus the drying time required at the same drying temperature was only 2 h.

Quality of crocodile jerky

Proximate compositions, total bacterial, Salmonella counts of fresh crocodile meat, and prepared crocodile jerky are shown in Table 7. Mitchell *et al.* (1995) reported that the average proximate compositions of fresh meat of *Crocodylus porosus* and *C. johnstoni* were 75.9 % moisture content, 21.1 % protein, 1.9 % fat and 0.95 % ash while Baek and Cadwallader (1997) reported the proximate composition of the tail meat of *Alligator mississippiensis* to be 29.1 % protein and 2.9 % fat. The fat content of *Crocodylus siamensis* from our study was as high as 5.5 % which might be due to its feed. However, it could be observed that the fat layer was separated from the muscle.

It was found that the process of crocodile jerky was effectively in reducing the number of bacteria. The product had a shear force, L*, a* and b* and a_w of 25.8 N, 41.5, 5.3, 9.4 and 0.63, respectively.

Deterioration at an accelerated temperature

The TBA number was chosen as a quality index in this study since it has been generally used to test rancidity in meat (Green and Cumeze, 1982). In general, the acceptable TBA value in food is less than 20 mg malonaldehyde/Kg sample (Shamberger *et al*., 1977). However, different types of food have different TBA values for a threshold of rancid odor, e.g., in cooked ground pork and beef, the values are 0.5-1.0 and 0.6-2.0 mg malonaldehyde/Kg, respectively (Tarladgis *et al.* 1960). For frozen and canned fish, it was reported as good quality when the TBA number was less than 3.0, however they were still acceptable when the number increased to 4-27 mg malonaldehyde/Kg (Shamberger *et al.* 1977*)*. For fishmeal, the initial TBA number was reported at 21, and a strong rancid odor was found at around 300 mg malonaldehyde/Kg (Green and Cumeze, 1982). Rancid odor in semi-dried catfish sticks could be detected when the TBA number exceeded 2.1 mg malonaldehyde/Kg (Pongchawee, 1994). The initial TBA number of dried fish was 3.1 (Pigott and Tucker, 1990). The panelists accepted fried pork sticks if the TBA number was lower than 3.54 mg malonaldehyde/Kg (Niyomkiatkul, 1986).

It was found that panelists could detect a rancid odor when the TBA number of the prepared

jerky exceeded 2.5 mg malonaldehyde/Kg. Therefore, this value was used as an index of quality during the shelf life study.

Shelflife

TBA numbers of crocodile jerky stored under different conditions are shown in Figure 1. Packaging conditions and storage time significantly affected the TBA number ($P \leq 0.05$). The TBA values of sample stored under air showed a trend to be higher than those stored under air with moisture absorber, under modified atmosphere with nitrogen or under air with oxygen absorber. It was also found that the TBA values of samples stored under air with oxygen absorber during the 12, 13 and 14th week were not significantly different ($P > 0.05$). According to the predetermined value of TBA from the accelerated storage condition, the shelf life of the products packed under air, air with a moisture absorber, air with an oxygen absorber and 100 % nitrogen were 7, 9, 14 and 13 weeks, with the TBA numbers of 2.53, 2.63, 2.52 and 2.55 mg malonaldehyde/Kg samples, respectively. The crocodile jerky product of Australia with 2 % fat was reported to have a shelflife of at least 1 year (www.alljerky.com/jerky_ product.html). The shorter shelflife of our products was resulted from the higher fat content (14.7 %).

CONCLUSION

Thai-style crocodile jerky can be prepared from the tail meat of cultured freshwater crocodile with the acceptability scores of 7-8 (like moderately

Table 1 Ratio Profile Test of crocodile jerky.

Attribute	Ideal score (I)	Sample score (S)	S/I
Color	5.70	6.12	1.08
Spice odor	6.57	5.18	0.78
Toughness	4.40	5.00	1.14
Hardness	4.12	5.73	1.43
Sweetness	5.51	4.32	0.79
Saltiness	5.21	4.73	0.91
Aftertaste	0.50	0.52	1.04

Table 2 Sensory evaluation scores of crocodile jerky with different soy sauce contents.

Sensory attribute	Sensory evaluation score ^{NS}		
	Soy sauce content		
	8.0 %	8.5 %	9.0 %
Appearance	6.9	6.8	6.8
Color	7.0	6.9	6.8
Odor	6.9	6.8	6.8
Flavor	7.0	6.9	6.8
Texture	6.8	6.8	7.0
Overall acceptability	7.1	6.9	6.8

^{NS} Not significantly different.

to like very much). TBA number can be used effectively as a quality index. Product packed in OPP/PE/Al/PE/OPP bag with oxygen absorber could be kept for 14 weeks. However, since deterioration of crocodile jerky is found to result from rancidity, the use of vacuum packaging might be able to extend shelf life of this product for longer than 14 weeks.

Table 3 Sensory evaluation scores of crocodile jerky with different sugar contents.

Sensory attribute	Sensory evaluation score[1]		
	Sugar content		
	5.0 %	6.5 %	8.0 %
Appearance	7.1 a	7.2 a	7.3 a
Color	7.1 a	7.2 a	7.2 a
Odor	7.0 a	7.2 a	7.2 a
Flavor	7.2 b	7.5 a	7.4 a
Texture	7.2 a	7.3 a	7.2 a
Overall acceptability	7.2 b	7.5 a	7.4 a

[1]Values in the same row followed by different letters are significantly different ($P \leq 0.05$).

Table 4 Sensory evaluation scores of crocodile jerky with different pepper contents.

Sensory attribute	Sensory evaluation score[1]		
	Pepper content		
	1.5 %	2.0 %	2.5 %
Appearance	7.4 a	7.4 a	7.4 a
Color	7.3 a	7.3 a	7.4 a
Odor	7.3 b	7.3 b	7.6 a
Flavor	7.1 c	7.4 b	7.8 a
Texture	7.1 a	7.1 a	7.2 a
Overall acceptability	7.1 c	7.4 b	7.7 a

[1] Values in the same row followed by different letters are significantly different ($P \leq 0.05$).

Table 5 Shear force of fried crocodile jerky dried at 50 or 60°C for 1.5 or 2.0 hours.

Drying temperature	Shear force (Newton)[1]	
	Drying time (hours)	
	50 °C	60 °C
1.5	12.4 d	14.1 c
2.0	16.0 b	20.4 a

[1] Values followed by different letters are significantly different ($P \leq 0.05$).

Table 6 Sensory evaluation scores of fried crocodile jerky dried at different times and temperatures.

Sensory attribute	Sensory evaluation score		
	Drying temperature		
	50 °C	60 °C	Means
Appearance			
Drying time 1.5 h	6.7	6.9	6.8 b
2.0 h	7.0	7.5	7.3 a
Means	6.9 B	7.2 A	
Color			
Drying time 1.5 h	6.2	6.7	6.5 b
2.0 h	6.8	7.6	7.2 a
Means	6.5 B	7.1 A	
Odor			
Drying time 1.5 h	7.2	7.2	7.2
2.0 h	7.2	7.3	7.2
Means	7.2	7.2	
Flavor			
Drying time 1.5 h	7.3	7.4	7.4
2.0 h	7.3	7.5	7.4
Means	7.3	7.4	
Texture			
Drying time 1.5 h	6.5	6.8	6.6 b
2.0 h	6.9	7.4	7.2 a
Means	6.7 B	7.1 A	
Overall acceptability			
Drying time 1.5 h	6.9	7.1	7.0 b
2.0 h	7.0	7.3	7.2 a
Means	7.0 B	7.2 A	

Means in the same row followed by different letters (A, B) are significantly different ($P \leq 0.05$).
Means in the same column followed by different letters (a, b) are significantly different ($P \leq 0.05$).

Table 7 Proximate compositions and microbiological quality of crocodile meat and jerky.

Composition and microbiological quality	Crocodile meat	Crocodile jerky
Moisture (%)	72.3	13.9
Protein (%)	20.2	48.2
Fat (%)	5.5	14.7
Ash (%)	1.0	5.3
Carbohydrate (%)	0.9	17.9
Total bacterial count (CFU/g)	1.48×10^6	N.D.
Salmonella (CFU/g)	N.D.	N.D.

N.D. not detected.

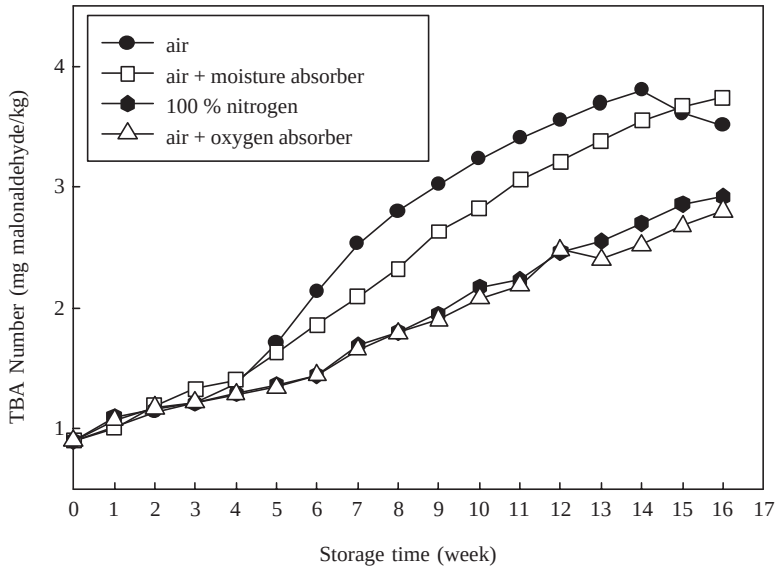

Figure 1 Change of TBA number of crocodile jerky stored under different conditions at ambient temperature.

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