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## Dried pork curry with cowa leaves sausage: the effect of drying time and temperature on quality attributes

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**Abstract** Pork curry with cowa leaves is made from traditional curry paste with cowa leaves and dried at different temperatures and times. The results showed that time and temperature had an impact on the colours of the sausage, with longer drying times which significantly resulted in a darker colour of the curry paste. The hardness of the texture was increased with prolonged drying. The pork curry with cowa leaves had a protein content of 18%, a fat content of 35%, and a fiber content of 3.43 %.

**Keywords:** Died sausage, Pork Curry with cowa leaves

### Introduction

Pork curry with cowa leaves is a traditional Thai dish from Chantaburi in eastern of Thailand with a rich history rooted in the culinary traditions. The specific history of pork curry with cowa leaves is not well-documented, but it is likely that it developed over centuries (Tagong and Apichayakul, 2023). Cowa leaves (*Garcinia cowa*), a tropical fruit native to Southeast Asia, have been used in Thai cuisine for centuries. Their sour and slightly bitter taste adds a unique flavor profile to dishes, making them a popular ingredient in many traditional recipes (Bureepakdee *et al.*, 2016; Muangthai and Nookaew, 2015). However, pork curry with cowa leaves has a short shelf life because there is a lot of water in the food. This leads to the food's rapid deterioration. Furthermore, it has not been developed into a variety of pork curry with cowa leaves products.

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Consequently, the researchers have transformed a traditional food from Chanthaburi Province into a novel product that is lighter and more convenient to consume by processing it into sausages, which are widely enjoyed across the nation (Sloyjalung, 2021). However, fresh sausages generally have shorter shelf lives than cured or dried sausages (Khorsandi *et al.*, 2019; Raimondi *et al.*, 2018). Drying is a critical step in the production of dried pork curry with cowa leaves sausage, as it reduces moisture content and inhibits microbial growth, thereby enhancing shelf stability. However, the drying process can significantly influence the quality attributes of the final product, including moisture content, water activity, color, texture, and sensory characteristics. Factors such as drying time and temperature can affect these attributes, leading to variations in the overall quality of the dried sausage. While the drying process contributes to its preservation. Despite its popularity, there is limited research on the impact of drying conditions on the quality attributes of this product (Feng *et al.*, 2014).

Understanding the relationship between drying conditions and product quality is essential for optimizing the production process and ensuring the consistent production of high-quality dried pork curry with cowa leaves sausage. The study aimed to investigate the effects of drying time and temperature on the quality attributes of pork curry with cowa leaves.

## **Materials and methods**

### ***Sausage preparation***

Fresh boneless chilled pork, lean pork, and back fat were purchased from a local market. The lean pork was ground through a 5 mm plate, and the back fat was sliced into 5 mm cubes. Curry paste powder obtained lemongrass (45 g), garlic (47 g), galangal (8 g), shallots (41 g), shrimp paste (36 g), pepper (25 g), dried chilies (98 g), and salt (25 g). Pork curry with cowa leaves sausages was prepared according to the following formulation: lean pork (1,300 g), back fat (700 g), curry paste powder (200 g), sugar (160 g), salt (26 g), and cowa leaves (140 g). The raw materials were mixed and stuffed into hog casings with a diameter of 25–30 mm. Then, raw sausages were tied into approximately 15 cm lengths manually.

### ***Dried pork curry with cowa leaves sausage***

The sausages were dried for the following times and temperatures: 24 hours, 36 hours, and 48 hours at 40 °C, 24 hours, 36 hours, and 48 hours at 50 °C, and 24 hours, 36 hours, and 48 hours at 60 °C by using a hot air oven purchased from Eureka (Thailand).

### ***Quality attributes***

Five sausages were randomly selected for each experiment. All experiments were repeated 3 times. The texture profile analysis was using a food texture analyser (LLOYD instrument, TA plus, UK 2007). The colour of dried sausage was measured using Konica Minolta Chroma Meters model CR-400/CR-410. The ash, protein, and fat content of dried pork curry with cowa leaves sausage were determined using the Association of Official Analytical Chemists (AOAC, 2019) criteria. The carbohydrate content was determined by calculation of the following equation: Carbohydrate =  $100 - (\text{protein} + \text{fat} + \text{moisture} + \text{ash})$  (Joymak *et al.*, 2021). The energy value of the fruiting body was determined by multiplying the protein content by 4, carbohydrate content by 4, and fat content by 9 (Manzi *et al.*, 2001). The data were presented as average values.

### ***Statistical analyses***

The experiment used a 3X3 Factorial in Complete Randomized Design. For the data, an analysis of variance (ANOVA) using the general linear model (GLM) procedure was performed, which considered When significant treatment effects were found, Duncan's multiple range tests were employed to determine any significant difference between different treatments. The values were considered significantly different when  $p \leq 0.05$ . Data were analysed using Microsoft Excel 356 and IBM SPSS Statistics.

## **Results**

### ***Effect on temperatures and times on the texture properties***

The texture properties that were produced by the pork curry with cowa leaves sausage were dried at different temperatures and for different amounts of time. The results indicated that there were statistically significant differences in mean values ( $p \leq 0.05$ ) of hardness and springiness, as shown in Table 1.

### ***Effect on temperatures and times on colour value of dried pork curry with cowa leaves sausage***

The colour properties of the dried pork curry with cowa leaves sausage were affected by both the drying temperature and the duration of drying (Table 2). The lightness ( $L^*$ ) of the sausage was enhanced by the thermal process ( $p \leq 0.05$ ). A comparable trend was observed in the  $a^*$  and  $b^*$  values ( $p \leq 0.05$ ).

**Table 1.** Effect on temperatures and times on the texture properties of Dried pork curry with cowa leaves sausage

Temperature (°C)	Time (Hours)	Hardness (N)	Cohesiveness <sup>ns</sup>	Springiness	Chewiness <sup>ns</sup> (N)
40	24	29.02±0.01 <sup>d</sup>	0.21±0.06	32.41±0.04 <sup>a</sup>	196.03±5.55
	36	29.71±0.01 <sup>cd</sup>	0.20±0.04	32.19±0.39 <sup>a</sup>	195.45±3.99
	48	30.20±0.02 <sup>bc</sup>	0.20±0.02	32.42±0.01 <sup>a</sup>	193.48±2.05
50	24	30.30±0.05 <sup>bc</sup>	0.22±0.06	31.87±0.95 <sup>a</sup>	218.19±1.49
	36	32.36±0.08 <sup>a</sup>	0.21±0.05	32.39±0.04 <sup>a</sup>	227.51±3.92
	48	32.46±0.07 <sup>a</sup>	0.26±0.10	25.60±1.80 <sup>c</sup>	219.37±3.32
60	24	30.30±0.03 <sup>bc</sup>	0.24±0.10	13.61±3.30 <sup>d</sup>	206.23±0.68
	36	30.89±0.07 <sup>b</sup>	0.27±0.02	16.55±0.76 <sup>c</sup>	174.65±0.73
	48	31.96±0.04 <sup>a</sup>	0.21±0.04	13.71±1.24 <sup>d</sup>	150.73±0.52

Note. Mean ± standard deviation, significance indicated the  $p \leq 0.05$  and *n.s.* indicates not significant at  $p > 0.05$

**Table 2.** Effect on temperatures and times on colour value of dried pork curry with cowa leaves sausage

Temperature (°C)	Time (Hours)	L*	a*	b*
40	24	40.61±0.40 <sup>b</sup>	16.30±0.34 <sup>a</sup>	17.01±0.49 <sup>b</sup>
	36	37.26±0.60 <sup>c</sup>	16.40±0.02 <sup>a</sup>	14.53±0.43 <sup>c</sup>
	48	37.64±0.06 <sup>c</sup>	15.76±1.06 <sup>b</sup>	14.01±0.10 <sup>c</sup>
50	24	40.61±1.83 <sup>b</sup>	17.55±0.66 <sup>a</sup>	19.03±3.29 <sup>a</sup>
	36	39.30±1.59 <sup>bc</sup>	14.47±1.20 <sup>c</sup>	14.54±0.65 <sup>c</sup>
	48	37.72±0.12 <sup>c</sup>	14.14±0.79 <sup>c</sup>	12.84±0.64 <sup>d</sup>
60	24	45.90±0.29 <sup>ba</sup>	17.80±2.72 <sup>a</sup>	19.78±1.25 <sup>a</sup>
	36	40.78±0.84 <sup>b</sup>	17.21±0.82 <sup>a</sup>	17.20±1.21 <sup>b</sup>
	48	37.28±0.38 <sup>dc</sup>	15.09±1.93 <sup>b</sup>	16.00±1.70 <sup>b</sup>

Note. Mean ± standard deviation, significance indicated the  $p \leq 0.05$  and *n.s.* indicates not significant at  $p > 0.05$

### ***Nutritional value of dried pork curry with cowa leaves sausage***

The nutrition value of dried pork curry with cowa leaves sausage is shown in Table 3. A 100 g serving of dried pork curry with cowa leaves sausage contained 18.63 g of protein, 35.71 g of fat, 3.43 g of ash, 11.70 g of carbohydrates, and 660 mg of sodium. The total energy was 442.71 kcal per 100 grams.

**Table 3.** Nutritional value of Dried pork curry with cowa leaves sausage

Nutrition Component	Nutrient content per 100 g
Protein (Nx4.38) (g)	18.63
Fat (g)	35.71
Ash (g)	3.43
Carbohydrates (g)	11.70
Sodium (mg)	660.25
Energy (kcal)	442.71

## Discussion

The hardness texture profile increased as the temperature and duration of use increased, resulting in a decrease in moisture content and a relative increase in hardness (Liu *et al.*, 2024; Mukherjee *et al.*, 2006). Several studies have confirmed this relationship in sausage production. Sobowale *et al.* (2019) reported that higher drying temperatures and extended drying times led to reduced moisture content in dried sausages. Similarly, Kim *et al.* (2022) found that the initial moisture content of semi-dried restructured sausages influenced drying time and thermal diffusivity, affecting final texture. Additionally, research on the baking process of sausages indicated that baking time significantly affected moisture distribution and hardness (Shang *et al.*, 2022). As temperatures increase, proteins in meat and other foods experience dehydration, resulting in a loss of their original structure and elasticity. The loss of structure reduces proteins' capacity to rebound, leading to a reduction in springiness (Pematilleke *et al.*, 2022; Zhang *et al.*, 2023). Denatured proteins create a more rigid, less elastic matrix, resulting in a harder texture. However, temperature and time of drying had no impact on the cohesiveness and chewiness of the products.

The decrease in colour values in sausages during thermal processing can be attributed to the Maillard reaction, which occurs when proteins and sugars react under heat, leading to browning (Adrian, 2019; Arihara *et al.*, 2021). Similarly, Bowers (2011) studied the impact of cooking temperature and time on sausage colour. Results show reduced moisture content leads to increased browning, with higher temperatures resulting in more intense browning. While this typically darkens the surface, the overall colour perception can be influenced by the colour of the sausage itself, especially if the exterior becomes more pronounced against a lighter interior. Furthermore, thermal processing can promote fat oxidation, which may darken the sausage. As fats break down, they can lead to darker, more intense flavours and colours, affecting the overall appearance (Feng *et al.*, 2020; Jiang *et al.*, 2023). As proteins denature under heat, they can also darken in colour (Hassoun *et al.*, 2020). Consumer perception

and acceptability are significantly influenced by the colour of dried sausage products, which is a critical quality attribute (Xu *et al.*, 2018).

Dried pork curry with cowa leaves sausage is a distinctive and savoury choice that features a significant nutritional profile. Containing 18.63 g of protein per 100 g, it delivers a substantial protein content, exceeding that of many conventional sausages, which generally contain approximately 10-15 g (Ahmad *et al.*, 2018). The fat level is considerable at 35.71 g, enhancing flavour and elevating calorie density to 442.71 kcal per 100 g, which is relatively high compared to typical pork sausages. The carbohydrate level is moderate at 11.70 g, perhaps affected by the incorporation of cowa leaves, which may contribute additional fiber and minerals (Phukhatmuen *et al.*, 2020). This sausage is notable for its protein content and flavour, rendering it an attractive option for anyone desiring a substantial and healthy meal enhancement; nonetheless, it should be consumed moderately because to its fat and sodium levels. The protein and fat content of meat products mostly depends on the nature of the raw materials utilized in sausage production (Halagarda *et al.*, 2018).

The study examined the impact of drying time and temperature on the quality of dried pork curry with cowa leaves sausage. It found that increased temperature and duration of use led to an increase in hardness texture, resulting in a decrease in moisture content and a relative increase in hardness. This increase was due to dehydration of proteins, reducing their structure and elasticity, and a harder texture. The study also found that thermal processing can cause a decrease in colour values due to the Maillard reaction and fat oxidation. The sausage, with its substantial protein content and moderate carbohydrate level, is an attractive option for those seeking a substantial and healthy meal enhancement.

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