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The impact of different packaging methods on physicochemical properties of yellow curry pastes products during storage period

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Abstract. The eventual quality of yellow curry paste packaging is influenced by the packaging method and materials. The presents study assessed the effect of packaging methods on yellow curry paste samples packed in polypropylene and multilayer packages. Yellow curry pastes samples (40-50°C, 150 g) packed in zipper pouch polypropylene, sealed multilayer non vacuum and vacuumed multilayer then stored at 30 °C for 35 days. Moisture content, water activity, pH and color were measured weekly for 35 days. The physicochemical of the yellow curry paste samples were significantly ($p<0.05$) affected by the interaction of packaging methods and storage period. The increase of moisture content in all packaging methods occurred on the 7th day with a range of 36.39-53.81%. The moisture content trends showed that both vacuum and non-vacuum multilayers were able to maintain moisture content changes after 7th day for 35 days storage period. The pH values of yellow curry paste samples for 35 days ranged from 4.96 to 5.19, 4.97 to 5.19 and 4.96 to 5.10 in zipper pouch polypropylene, sealed multilayer non-vacuum and vacuumed multilayer respectively. The pH trends obtained for all method packaging increased on the 7th day could be due to the oxidation process. The highest aw 0.80 was recorded from vacuumed multilayer packaging on 35 days. The lowest aw 0.69 was recorded for samples stored for 28 days packed in zipper pouch polypropylene. A significant difference color (L* a* b*) on 0- and 35-days storage was shown in the yellow curry paste sample packed in polypropylene. Multilayer material with a vacuum method can be recommended for packaging yellow curry paste based on moisture content, water activity, pH, and color parameters. *

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1 Introduction

Indonesian yellow curry paste is full of bold, savory and even spicy flavors. It's a combination of rich, earthy spices and seasonings often found in curry. The mains ingredients of Indonesian yellow curry paste are shallots, garlic, turmeric, lemongrass, ginger, brown sugar, bay leaf, salt, cinnamon, margarine, cooking oil and candlenuts. In Indonesia, yellow curry paste is processed into a traditional dish which made from beef, namely "empal gentong". Yellow curry paste is currently packaged in glass jar with lid, polypropylene combination bag, the commercially sterile with cans and flexible packaging at high temperature [1,2]. However, the basic ingredients of yellow curry paste that consist of spices and rhizomes will deteriorate these bioactive compounds if exposed to high temperatures.

Vacuum packaging is the most common method to remove the air around the product, using a suitable packaging material [3]. The vacuum method usually combines with any type of plastic packaging because of flexible, easy formed, heat seal characteristics and have a barrier to gasses and vapours. Packaging materials of polyethylene (PE) and polypropylene (PP) can reduce moisture content, maintain protein content and lowering pH value [2,4].

The effects of reduced water activity and different packaging materials were investigated regarding shelf-life extension of Thai red curry paste and sour curry paste. Curry pastes were vacuum packed in alumunium foil and nylon bags and stored at 25°C for 8 weeks. Results showed that nylon bags gave higher shelf-life for curry pastes during storage period [5].

In previous studies [2], vacuum method with PP packaging material tends to maintain a decrease pH value of yellow seasoned "pindang" fish product. The packaging methods had a significant effect on the moisture content and product lightness at 7th and 14th day. The vacuum method is more effective in reducing the rate of moisture content of yellow seasoned "pindang" fish product during storage.

Packaging methods and type of packaging materials are important factors in controlling quality changes of paste seasoning. The characteristics of the packed food product are significantly affected by the type and proportion of ingredients used. The use of improper packaging materials is a key challenge, which affects the quality of food products during transportation and storage. Packaging materials differ in their permeability to oxygen and moisture also choice of appropriate packaging material is vital [6]. Three different multilayer packaging materials were used to pack food paste ready-to-eat. The results showed that the rapidly deteriorating changes were observed in the food paste packaged in 40 μm metallic foil laminated low-density polyethylene pouches compared to alumunium foil laminated low-density polyethylene [7].

The objective of this study is to observe physical (color), and chemical (moisture content, water activity and pH) changes of this packed yellow curry paste that occur during storage period under varying packaging methods.

2 Materials and methods

2.1 Experimental materials and sample preparation

Yellow curry paste produced by "CV Sazada Pratama Mandiri Cirebon" was used in this study. Two packaging materials namely polypropylene (PP) and multilayer (PET/Al/Nylon/CPP) were purchased from the online market.

The yellow curry pastes samples (40-50°C, 150 g) were packed in polypropylene and multilayer each a headspace 60% [8]. Packaging method with a different sealed treatment that is non vacuum, and vacuum [2]. A Polypropylene sample packaged (P1) with zipper seal was used as control. Non vacuum multilayer packaging sample sealed with continuous band sealer machine (China) at temperature 250 °C (P2). At the same time sample of multilayer packaging were vacuumed in vacuum packer DZ 500/2D (China) on vacuum 25 seconds, sealing 2.5 seconds and high temperature (P3). The preparation of yellow curry pastes and packaging size are presented in Table 1. The samples were incubated at temperature 30°C (incubator BINDER) for 35 days. Samples were removed and analysed at seven-day intervals for a change in quality.

Table 1. Packaging methods and packaging sizes of yellow curry paste.

Packaging methods	Package material	Width (mm)	Height (mm)	Thickness (mm)
P1 (Zipper pouch)	Polypropylene	1370	220	0.096
P2 (non-vacuum, sealed at T=250 °C)	Multilayer packaging (PET/Al/Nylon/CPP)	1300	204	0.112
P3 (Vacuumed 25s, sealed 2.5s, high temp)	Multilayer packaging (PET/Al/Nylon/CPP)	1300	204	0.112

2.2 Chemical analysis

The yellow curry paste samples were evaluated for moisture content, water activity, pH, and color.

2.2.1 Moisture content

The moisture content of the samples were determined by OHAUS MB 120 Moisture analyzer with 0.5 g weighing sample and temperature 105°C [9].

2.2.2 Water activity (Aw)

Water activity was measured by half-filling the sample cups then sealed with the chamber of water activity meter (Aqualab Pawkit water activity meter P08714 Decagon devices Pullman). The aw of sample was determined at 24 – 26°C during about 5 minutes [5,8].

2.2.3 pH

Approximately 20 g of the yellow curry paste added with 50 mL aquadest then stirred for 1 minute. The mixture was measured using pH meter "Eutech" instruments PC 700 at temperature of 25 -26°C [9,10].

2.3 Color analysis

The change of color attributes of yellow curry paste samples were measured using Spectrophotometer CM-5 Konica Minolta Sensing (Singapore). The data results were expressed as L* (lightness; 0=black, 100=white), a* (+a*=redness, -a*=greenness) and b* (+b*=yellowness, -b*=blueness) [9,11].

2.4 Statistical analysis

Analysis of variance was used to determine the effects of storage period and packaging methods on moisture content, pH, water activity and color (L*a*b*) at the 5% level of significance. All analysis were repeated three times. Data were analyzed using CoStat 6.4.

3 Results and discussion

ANOVA results showed that moisture content, pH, Aw and color were significantly influenced by the interaction of storage period and packaging method. The main effects of all factors did significantly affect all measured responses of the stored yellow curry paste samples (Table 2).

Table 2. ANOVA p-values for main and interaction effects of storage period (A) and packaging method (B) on moisture content, pH, Aw and color of yellow curry paste

Term	Moisture content (%)	pH	Aw	Color		
				L*	a*	b*
A	0.000*	0.000*	0.002*	0.000*	0.000*	0.000*
B	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
A*B	0.000*	0.002*	0.000*	0.000*	0.000*	0.000*
Predicted R-Sq	0.973	0.911	0.930	0.826	0.829	0.861
Adjusted R-Sq	0.961	0.869	0.898	0.744	0.748	0.796

*Significant difference $p<0.05$

3.1 Moisture content

Figure 1 shows that throughout the storage period, yellow curry paste packed in polypropylene (PP) is significantly affected ($p<0.05$) to moisture content changes. has an excellent moisture barrier (WVTR: 0.6 g/m2.d), while multilayer packaging is in the range value WVTR (0.2 – 1.3 g/m2.d) [12]. Increase of moisture content in all packaging methods occurred on the 7th day with a range of 36.39-53.81%. This is because water is a requirement for bacteria growth and metabolism, and supports many chemical reactions that occur in food products [13]. Moisture content in PP packaging decreased on the 14th day and then increased on the 21 -35th day. This unique phenomenon might be due to adsorption and desorption isotherm processes [14]. The changes of moisture content, apart from being influenced by microbial activity, are also influenced by the movement of the water either adsorb or desorb into the samples during storage process.

Yellow curry paste packed in multilayer with vacuum and non-vacuum methods were not significantly affected to moisture content changes. The moisture content trends showed that both vacuum and non-vacuum multilayer were able to maintain moisture content changes after 7th day for 35 days storage period. The shelf life of polyethylene coated, and vacuum packaged chicken breast was increased to 12 days as the longest storage time. Packaging provides moisture, gas, and aroma barrier to space food, ultimately enhancing the food's shelf life [15]. This extension is roughly equivalent to a 100% shelf-life extension of the product. This confirms the potential utility of the hurdle strategy for improving the shelf life of raw poultry meat.

The vacuum method can reduce the rate of increase moisture content because water vapor and gases have been removed from the packaging. In this hermetic condition, the growth of aerobic microbes can be inhibited. The multilayers thickness plays a role in the transfer of water vapor from the environment into the packaging through the packaging pores [2].

3.2 pH changes

The pH is one of the important parameters to characterize food deterioration. It is an indicative of food spoilage and can indicate to the consumer any food quality changes. As shown in Figure 2, the pH values of yellow curry paste samples during storage period 35 days ranged from 4.96 to 5.19, 4.97 to 5.19 and 4.96 to 5.10 in zipper pouch polypropylene, sealed multilayer non-vacuum and vacuumed multilayer respectively. The changes of pH values of yellow curry paste in zipper pouch polypropylene and sealed multilayer were not significantly different. However, the vacuumed multilayer significantly affected ($p<0.05$) to pH values of yellow curry paste samples during storage period 35 days. Vacuumed packaging tends to prevent microbial and fungal activities.

The pH trends obtained for all method packaging increased on the 7th day could be due to the process of making yellow curry paste containing cooking oil. Moreover, the oxidation of aldehyde during processing and storage period may have been responsible for the increase of acidity. The increase in acidity has an inhibitory impact on the growth rate of pathogens [11]. The moisture content in the samples also has an affect fungal/bacteria contamination resulting in increased enzymatic oxidizing activity [16]. After 28 days of storage, a decrease in the pH values of yellow curry paste samples was observed. The decrease in pH of yellow curry paste samples on all packaging methods indicates the organic acids that are produced by bacteria [17].

3.3 Water activity (Aw)

Figure 3 presents the water activity values of the stored yellow curry paste samples. The highest aw 0.80 was recorded from vacuumed multilayer packaging on 35 days. The lowest aw 0.69 was recorded for samples stored for 28 days packed in zipper pouch polypropylene. Water activity is an indirect measure of the free water available to the microorganism in the food system. Therefore free water in foods is required to support the growth of yeasts, molds and bacteria [18].

Yellow curry paste packed in zipper pouch polypropylene was different significant ($p<0.05$) on aw values, while samples packed in both sealed multilayer non-vacuum and vacuumed multilayer were not different significant. Zipper pouch polypropylene has a thickness size of 0.096 mm, thinner than multilayer. The possible explanation for the strange water activity on flour samples packed in woven polypropylene bags could be the fact that this packaging materials is not hermetic that means moisture and other gases can penetrate the packaging material via two processes, namely diffusion and sorption-desorption [6]. In the range aw 0.60-1.00, microbial growth rate is the dominant factor. Bacteria cells will gain moisture from their microenvironment when the aw of the foods is higher than that of bacterial cells. On the other hand, the bacteria cells would be dehydrated if a lower aw is provided by a food system [16,17]. Figure 3 indicates that the water activity values of yellow curry paste samples stored in multilayer packaging were relatively constant. Therefore, multilayer packaging is the best material for yellow curry paste packaging based only on aw.

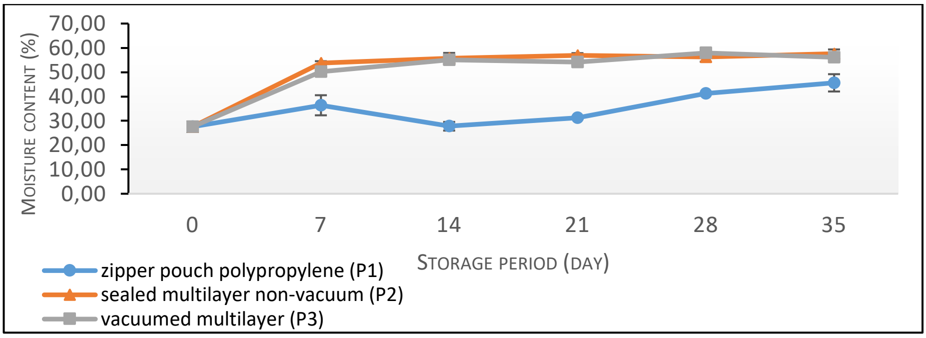

Fig 1. Moisture content changes of yellow curry paste at different packaging methods.

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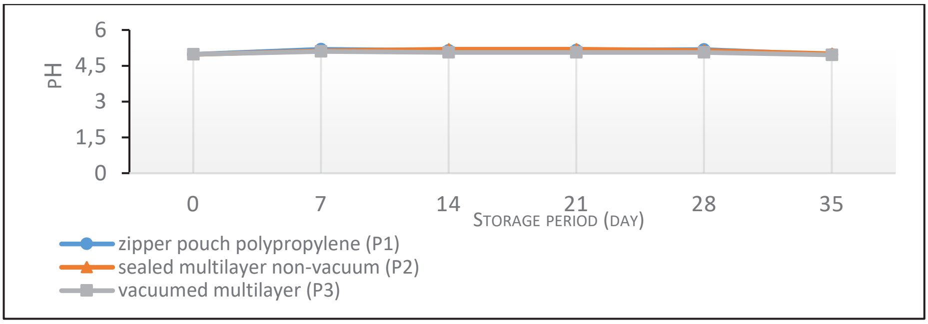

Fig 2. pH changes of yellow curry paste at different packaging methods.

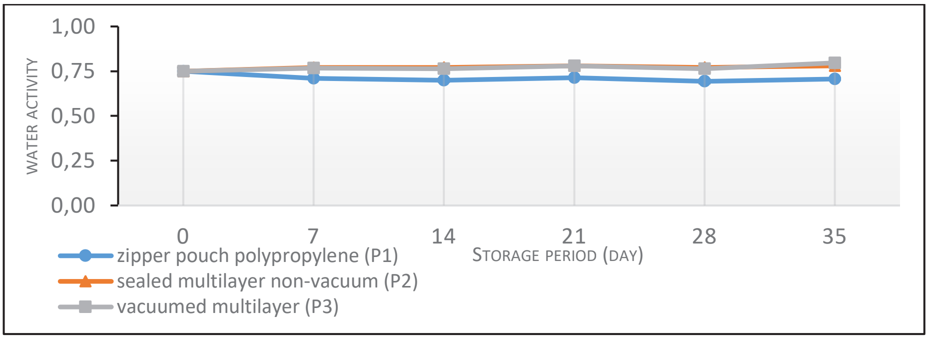

Fig 3. Water activity changes of yellow curry paste at different packaging methods.

3.4 Color

The measurements of color attributes of stored yellow curry paste samples with different packaging methods are displayed in Table 3. It was observed that L* and a* values of yellow curry paste packed in zipper pouch polypropylene increased significantly ($p<0.05$) after 0 and 35 days of storage. On contrary, b* values revealed a significant decrease after 0 and 35 days of storage. The L* and a* values on yellow curry paste packed in sealed multilayer non-vacuum decreased insignificantly ($p>0.05$), while b* values decreased significantly ($p<0.05$) from 40.75 to 34.05 after 0 and 35 days of storage. The yellow curry pastes samples packed in vacuumed multilayer showed L* values decreased significantly ($p<0.05$) from 29.61 to 27.63, and b* values revealed a significant decrease from 40.75 to 31.80, while a* values decreased insignificantly after 0 and 35 days of storage. A significant difference was shown in the yellow curry paste sample packed in polypropylene, the average L* and a* values increased after 0 and 35 days of storage.

The L* values will increase if the sample color is faded, or the sample color is close to white. The a* values will increase when sample color becomes reddish and will decrease when it becomes yellowish. Meanwhile, the b* values (degree of yellowness) in polypropylene and multilayer packaging decreased during the storage period. The increase in L* and a* values on transparent polypropylene packaging is caused by light exposure that interacts with chemical compounds from the raw material for making yellow curry paste. The raw materials include shallots, garlic, turmeric, lemongrass, ginger, brown sugar, bay leaf, salt, cinnamon, margarine, cooking oil and candlenuts. Similar to results reported that the increase value in a* due to the addition of the spice of chili and turmeric of Thai red curry paste [5]. The red color shows the level of anthocyanin pigments in the form of red flavium cations, but the pigments changes during the storage period [5]. Color pigments changes during storage are caused by the presence of oxygen, temperature, and light exposure. Moreover, the curcumin in turmeric is sensitive to oxidation reactions when exposed to oxygen and light. The instability of curcumin can be influenced by the presence of light which results in photochemical degradation. This change occurs due to the formation of ferruilmethane compounds (brownish-yellow visual) resulting from curcumin degradation [19].

Table 3. Change in color of yellow curry paste samples packed in polypropylene, multilayer non-vacuum, and multilayer vacuum during storage period.

Packaging method	Storage (days)	Color parameter		
		L*	a*	b*
Zipper pouch polypropylene (P1)	0	29.51±0.28[bc]	11.74±0.14[b]	40.75±0.77[a]
	7	30.30±0.31[ab]	11.31±0.43[c]	33.31±0.47[d]
	14	30.05±0.31[b]	11.00±0.26[c]	34.34±0.95[cd]
	21	29.17±0.13[bc]	11.24±0.09[c]	40.21±0.15[a]
	28	28.84±0.33[c]	11.97±0.20[b]	37.13±2.06[b]
	35	31.29±1.37[a]	12.56±0.06[a]	35.50±0.57[bc]
Sealed multilayer non-vacuum. (P2)	0	29.51±0.28[a]	11.74±0.14[ab]	40.75±0.77[a]
	7	27.86±0.22[c]	12.01±0.16[a]	40.17±0.19[ab]
	14	28.78±0.09[ab]	10.70±0.13[c]	36.46±0.05[bc]
	21	28.10±0.20[bc]	11.87±0.10[a]	37.89±0.37[ab]
	28	29.24±0.24[a]	10.88±0.36[c]	33.80±0.80[c]
	35	29.13±1.01[a]	11.16±0.74[bc]	34.05±4.72[c]
Vacuumed multilayer (P3)	0	29.51±0.28[a]	11.74±0.14[a]	40.75±0.77[a]
	7	26.86±0.30[b]	11.09±0.01[ab]	32.91±0.93[b]
	14	27.76±0.18[b]	10.00±0.58[d]	30.70±0.60[b]
	21	27.77±0.33[b]	10.55±0.20[bcd]	30.87±1.25[b]
	28	28.00±0.53[b]	10.17±0.62[cd]	29.86±2.31[b]
	35	27.63±1.61[b]	11.04±0.73[abc]	31.80±4.48[b]

Values are presented as mean ± standard deviation. Values with different lowercase superscript within the same column on each packaging method are significantly different ($p<0.05$)

4 Conclusion

Yellow curry pastes, which are packed in multilayer packaging material with vacuum or non-vacuum, were able to maintain moisture content changes after 7^{th} day for 35 days storage period. Moreover, the water activity and pH values of yellow curry paste samples stored in multilayer packaging were relatively constant. The transparent polypropylene packaging influences the color changes of yellow curry paste during storage period. Therefore, multilayer material with a vacuum method can be recommended for packaging yellow curry paste based on moisture content, water activity, pH, and color parameters.

5 Conflict of interest

The authors declare no conflict of interest.

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