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THE EFFECTS OF DIFFERENT PACKAGING MATERIALS ON PHYSICOCHEMICAL AND SENSORIAL PROPERTIES OF *REMPEYEK*

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Abstract

This study was conducted to determine the effects of different packaging materials on the physicochemical and sensorial properties of traditional fried snack, *Rempeyek*. The samples were physically analysed for the texture (hardness) and color. Peroxide Value (PV) and Acid Value (AV) were the chemical analyses used to measure the rancidity level of *Rempeyek* during storage. On the other hand, Quantitative Descriptive Analysis (QDA) was conducted to describe the sensory characteristics of *Rempeyek*. All analyses were carried out for an interval of every month until 2 months of storage. The *Rempeyek* samples in this study were packed in five different types of packaging including Polyethylene Terephthalate (PETE or PET), PET with oxygen absorber, Low-Density Polyethylene (LDPE), LDPE with oxygen absorber and aluminium layer. In terms of hardness, *Rempeyek* that were packed in PET with oxygen absorber required the lowest force with 1198.93 ± 78.70 (g) while LDPE showed the highest force to break the sample with 2669.86 ± 905.72 (g) for 2 months of storage. The lightness (L*) and redness (a*) of *Rempeyek* decreased gradually while the yellowness (b*) displayed fluctuation readings along with the storage. Besides, the rancidity level of *Rempeyek* that was determined through PV significantly increased from 0 month (5.58 – 6.41 meq/g) to 2 months (14.42 – 39.75 meq/g) of storage. Similarly, the AV was significantly increased from 0 month (1.51 – 1.71 mg KOH/g) to 2 months (4.37 – 6.17 mg KOH/g) of storage. In terms of QDA, the color of *Rempeyek* showed no significant changes but the score for aroma was significantly reduced from 0 month to 2 months of storage in LDPE and LDPE with oxygen absorber. Meanwhile, the scores for taste and hardness were reduced significantly from 0 month to 2 months of storage regardless of the types of packaging used.

1. Introduction

Rempeyek is a very common and popular traditional deep fried snack among the Malays in Malaysia. Traditional foods which are often related to the local foods use specific local ingredients and are produced locally based on the knowledge and expertise of the local people. *Rempeyek*, a deep fried cracker that is highly in demand during the Malay's festive season, is made of rice flour and tapioca flour with an addition of other ingredients which includes coconut milk, eggs, anchovies, shallot, garlic, coriander seeds and salt. There are various types of *Rempeyek* but the most favourable among Malaysians is the one with anchovies and peanuts. Fried food have unique sensorial properties, which make them very attractive to the consumers (Mihaela et al., 2013). There are numerous Small Medium Enterprise (SMEs) in Malaysia that produce *Rempeyek* as it always has market demand due to its unique savory taste with crispy texture besides it requires low production cost to start the business activity. Even though *Rempeyek* is categorised as renowned Malaysian traditional fried snack for decades, there is still no *Rempeyek* brand in Malaysia which can penetrate to a higher level market like other commercial snacks. This might be due to few factors such as packaging, shelf life and marketing strategy. A good packaging is very much important because packaging does not only function to keep and protect the content but also as a medium to attract and educate the consumers about the product. Food packaging can help to extend the shelf life of food by conserving the product from deterioration, retaining the beneficial effects of processing, maintaining or improving the quality and safety of food (Marsh et al., 2007).

Rempeyek requires a good packaging because it is categorised as a deep fried snack which is prone to rancid during storage especially when the packaging is improper. Marsh et al., (2007) stated that packaging provides protection from three major classes of external influences including chemical, biological and physical factors. However, a good packaging of materials will increase the production cost, in which not many entrepreneurs are willing to spend on these. A deep-fried snack should be packaged in a grease-proof food packaging as it will reduce the chances of rancidity. Abong et al., (2011) reported that the packaging materials and storage temperature influenced the shelf life of fried snack such as potato crisps. Therefore, rancidity can be minimized by a proper choice of packaging and storage temperature. Another packaging requirement for a deep fried snack is low oxygen permeability that has an ability to prevent the product from having contact with oxygen in the air that will promote further oxidative rancidity. Other than that, one of the major properties of a deep fried snack is crispiness. It is achieved from moisture reduction during frying. This shows that crispiness is directly related to the moisture level in a product. Therefore, a good packaging for a deep fried snack should also possess a good barrier towards moisture.

The greatest challenge for a deep fried snack industry like *Rempeyek* is to maintain the sensory qualities for a long time because it will face uncontrollable external factors during storage that promotes the deterioration process. There are so many packages available in the market that can be used for a deep fried snack ranging from the cheapest to the most expensive one. The most common packaging material preferred by the SMEs that run a deep fried snack production is the plastic type packaging which is not only capable of protecting food from moisture, humidity, gases, microorganisms, insects, and inert but also lightweight and cheap. Polyethylene (PE) is versatile plastic polymer that is widely used as food packaging and other food products. High Density Polyethylene (HDPE) is lightweight but strong enough to carry a gallon of milk than the Low Density Polyethylene (LDPE). LDPE is usually used to pack a deep fried snack due to its resistance towards water and oxygen, besides thinner in structure and is flexible. While, Polyethylene terephthalate (PETE or PET) is a lightweight plastic that is made to be semi-rigid or rigid and is usually made as a recyclable food container which is more impact resistant, and helps to protect the food or liquid inside the packaging (Kirwan et al., 2011).

Rancidity will be accelerating by the presence of heat, moisture and light, as well as the added salt in the product. Tiwari et al. (2011) stated that rancidity is the common off-flavour developed in deep fried snacks. One of the methods to prevent rancidity is by using proper packaging that can protect the *Rempeyek* from oxygen, light and heat. It is important to control the contact of *Rempeyek* with oxygen as low as possible. The results obtained from this study help SMEs in choosing the best packaging that can maintain the quality and prolong the shelf life of their deep fried snack products during storage. This study was done as a result of limited information available for the quality improvement of *Rempeyek* as Malaysians traditional deep fried snack. The objective of this research was to determine the effects of different packaging materials on physicochemical and sensorial properties of *Rempeyek.*

2. Methods

2.1 Preparation of Rempeyek

All raw materials were purchased from the Giant Hypermarket Seksyen 7, Shah Alam. The batter of *Rempeyek* was prepared by mixing ingredients A (blended anchovies, shallot, garlic, cumin seeds and coriander seeds) with rice flour, tapioca flour, eggs, coconut milk and salt by using an electrical mixer for 10 minutes. The moulding process was done by preheating the mould in hot cooking oil for about 2 minutes. After that, the batter was poured onto the preheated mould and once the batter started to harden, the excess batter was poured back to the bowl. The groundnuts were sprinkled on the semi-solid mixture. The semi-solid mixture was deep-fried for 3 minutes until it turned golden brown. The *Rempeyek* was then cooled down, packed, and stored at room temperature until further analysis.

2.2 Determination of Texture (Hardness)

The texture (hardness) of *Rempeyek* in this study was determined by using texture analyser, TA.XT.T2i (Stable Micro System, United Kingdom) which used 30 kg load cell. Both pre-test speed and test speed was 1 mm/s, while the post-test speed was 10 mm/s. Three points bending test was applied to measure the maximum force (N), for the hardness of the snack and at least ten different samples were measured (Cakmak et al., 2015).

2.3 Determination of Color (L, a, b)

The color of *Rempeyek* was measured by using chroma meter (CR-400, Konica Minolta, Japan). The chroma meter used CIE system that was called CIELAB with coordinates (L*, a*, b*) and was directly read. The measurement considered two color coordinates: a* (positive values for reddish and negative values for the greenish) and b* (positive values for yellowish and negative values for bluish) as well as psychometric index of lightness, L* (an approximate measurement of luminosity of the greyscale; between black and white) (Pathare et al., 2013). The L,a,b value was measured by placing the camera flash to the front side of *Rempeyek.*

2.4 Determination of Peroxide Value (PV)

Peroxide value (PV) measures peroxides; by-product of oxidative rancidity in oil. PV is determined by measuring the iodine released from potassium iodide. One g of oil that has been extracted from the *Rempeyek* sample was placed into clean test tubes. One gram of potassium iodide powder and 20 mL solvent mixture (glacial acetic acid and chloroform with ratio of 2:1 (v/v)) were added while the sample was still in liquid form. The mixture in the test tube was boiled vigorously in boiling water for 30 seconds. The sample was poured immediately into a conical flask containing 20 mL of 5% potassium iodide solution. Using distilled water, the test tube was rinsed and the content was titrated with 0.002 M sodium thiosulphate until the yellow color disappeared. Five drops of 1% starch solution was added, to give a color of light blue. The mixture was titrated again until the color of light blue was discharged (Nadya et al., 2017).The analysis was performed in triplicate. The measurement of peroxide value was calculated as followed:

Peroxide value = (Vs-Vb)/(Weight of sample) x T x 10^3
T = molarity of sodium thiosulphate
Vs = volume in mL titration of sample
Vb = volume in mL titration for blank

2.5 Determination of Acid value (AV)

Acid Value (AV) was determined by mixing 25 mL of diethyl ether with 25 mL alcohol and was added with 1 mL of 1% phenolphthalein solution as an indicator. This mixture was neutralised by 0.1 M KOH. One to 10g of oil sample was dissolved into the neutralized mixture and was shaken continuously. While titrating with 0.1M KOH was done until the color of pink persisted, for about 15 seconds (Micheal et al., 2014).

Acid Value = titre value (ml) X 5.61/weight of sample used (g)

2.6 Sensory Analysis using Quantitative Descriptive Analysis (QDA)

QDA test was carried out by referring to the test proposed and developed by Hootman (1992) and Rogers (2018). At first, 30 candidates were recruited during the screening stage to find out potential panelists with the capabilities of discriminating the level of sensory qualities of food products through paired-comparison methods. Based on the screening results, candidates who scored the minimum of 65% correct answers and showed good commitment throughout the training session were chosen as QDA panelists (10-trained panelists). A panel leader acted as the facilitator to lead the discussion with 10 chosen panelists in developing the scorecard with suitable *Rempeyek's* attributes. This line-scale scorecard was used as a sensory form during the testing stage. The 10 chosen panelists were trained for a few times to agree with consensus on the *Rempeyek's* attributes on the scorecard. The line-scale scorecard was designed as 6-inch in length with sensory intensities word anchors located 0.5 inch from each end. The scale direction went from left to right with increasing intensities from weak to strong. The attributes used include color, aroma, rancidity, oiliness, crispiness and taste.

2.7 Statistical Analysis

Data obtained from the experimental measurements were subjected to SPSS Analysis of Variance (ANOVA) software to determine the significant differences among the treatments defined at α=0.05. All the experiments were carried out in triplicate and were report as mean ± standard deviation of independent trials (AOAC, 2011).

3. Results and Discussion

3.1 Determination of Texture (Hardness)

Hardness refers to the force (g) required for a pre-determined deformation of food products. There was no significant difference between *Rempeyek* for different treatments in 0 month of storage. PET with oxygen absorber required the lowest force with 1198.93 ± 78.70 (g) while LDPE showed the highest force to break the sample with 2669.86 ± 905.72 (g) for 2 months of storage. During sampling preparation, *Rempeyek* underwent a frying stage that made the surface of food lost the moisture content, led to the dehydration of crust and increased the hardness of the food (Oyedeji et al., 2017). On the other hand, snacks will normally take up water, lose their specific crispiness and become harsh during storage. The undesirable changes that occur are depending on certain factors of initial moisture content, types of ingredients (spices), type of wrapper, storage condition and duration of storage (Talbot, 2011).

Table 1: Hardness of *Rempeyek* for 2 months of storage

Packaging materials	**Months of storage**		
	0	1	2
Aluminium	1199.94±4.05	1201.34±28.66	1694.76±15.15
LDPE	1176.31±146.24	1478.04±18.58	1263.08±28.23
LDPE with oxygen absorber	1283.03±37.63	1367.19±37.09	1198.93±78.70
PET	1214.59±36.56	1178.50±65.90	2669.86±905.72
PET with oxygen absorber	1236.92±15.74	2206.22±57.16	2438.41±161.99

3.2 Determination of Color (L, a, b)

Lightness (L), redness (a), and yellowness (b) are color parameters that are widely used to evaluate color changes during 2 months storage. L, a, b values for *Rempeyek* were shown in Table

2. The lightness (L*) and redness (a*) of *Rempeyek* decreased gradually while the yellowness (b*) displayed fluctuation readings along storage. The remains of food present in frying oil which caused by the formation of Maillard compounds also caused the frying oil to become darkened (Maniak *et al*., 2012). During frying, the fried products experienced increase in browning reaction due to Maillard reaction resulting from the utilization of available reducing sugars and protein.

Table 2: Changes in Lightness (L*) of *Rempeyek* for 2 months of storage

Packaging materials	**Months of storage**		
	0	1	2
Aluminium	37.88±0.11	37.24±0.27	27.62±0.01
LDPE	39.67±1.08	37.04±0.41	32.39±0.01
LDPE with oxygen absorber	38.88±0.36	30.99±0.43	40.75±0.01
PET	37.11±0.34	34.65±0.28	35.41±0.01
PET with oxygen absorber	39.20±0.27	39.91±0.43	29.43±1.23

Based on the Table 2, the lightness of *Rempeyek* significantly reduced from 0 month to 2 months of storage in all types of packaging. There was a significant reduction on the L* value of *Rempeyek* at different months of storage except for PET with oxygen absorber. According to (Oyedeji et al., 2017), lightness (L*) is a crucial color parameter used as a quality control of fried foods. The study proved that fresh *Rempeyek* sample will have higher L* value than the stored *Rempeyek.*

Table 3: Changes in redness (a*) of *Rempeyek* for 2 months of storage

Packaging materials	**Months of storage**		
	0	1	2
Aluminium	7.95±0.07	6.32±0.40	6.06±0.00
LDPE	7.65±0.36	6.55±0.49	6.33±0.08
LDPE with oxygen absorber	7.40±0.37	8.46±0.27	4.80±0.01
PET	7.90±0.13	7.40±0.04	5.11±0.03
PET with oxygen absorber	7.98±0.08	4.90±0.11	5.44±0.27

The a* value is the chromatic redness parameter in which value means red color when positive and green color when negative (Pathare et al., 2013). The a* value of the front side of *Rempeyek* in this study decreased significantly upon storage time. This shows that, fresh *Rempeyek* possess higher a* value than the stored *Rempeyek.* Aluminium packaging can preserve the color changes in deep fried snacks better than PET packaging which widely used by the SMEs. The positive a* value obtained in this study which refers to redness is due to the development of crust in fried products (Oyedeji et al., 2017).

Table 4: Changes in yellowness (b*) of *Rempeyek* for 2 months of storage

Packaging materials	**Months of storage**		
	0	1	2
Aluminium	22.07±0.08	22.11±0.53	21.53±0.03
LDPE	22.12±0.33	20.71±0.33	19.07±0.04
LDPE with oxygen absorber	22.10±0.29	21.94±0.67	25.85±0.03
PET	22.06±0.25	22.76±0.27	16.97±0.05
PET with oxygen absorber	22.26±0.06	26.79±0.23	23.92±1.46

The b* value displayed in Table 4 is refers to the chromatic yellowness parameter, in which value means yellow color when positive and blue color when negative (George *et al*., 2011). The results showed that there was no significant difference between all treatments during 0 month of storage and between all months in aluminium packaging. Mostaghim et al., (2013) found that there will not be any changes in color during the storage of snack food.

3.3 Determination of Peroxide Value (PV)

Peroxide value (PV) is commonly used to indicate the initial stage of lipid oxidation (Jung Min, 2016). PV shows the milliequivalent of peroxide oxygen found in a kilogram of oil and is able to free the iodine from potassium iodide. It helps to measure the quality and stability of lipids and its product. Zahir et al., (2014) reported that PV increases correspond with the storage time, contact with air of the oil samples and temperature. This was aligned with the PV trend in this study where PV increased significantly from 0 month to 2 months of storage for all types of packages.

Table 5: Peroxide Value (meq/g oil) of *Rempeyek* from different types of packages for 2 months of storage

Packaging materials	**Months of storage**		
	0	1	2
Aluminium	6.00±0.18	8.08±0.09	14.42±0.28
LDPE	5.58±0.33	23.42±0.12	39.75±0.56
LDPE with oxygen absorber	5.75±0.32	9.77±0.39	39.55±0.55
PET	6.08±0.32	13.51±0.07	32.35±0.15
PET with oxygen absorber	6.41±0.23	9.84±0.26	21.96±0.38

Based on the PV trend, rancidity might be developed in the product upon 30 days of storage and the product can be consumed if the peroxide level is <5 meq/kg of oil (Uma Tiwari *et al*., 20011). Similarly, PV of the Indian fried snack incorporated with ivy gourd increased during storage of 45 days in both Low Density Polyethylene (LDPE) and Metallised Polyester packaging (Vinothini et al., 2015). PV between 1-5 meq/kg indicates low oxidation level, 5-10 meq/kg indicates moderate oxidation level, and above 10 meq/kg is classified as high oxidation state (Moigradean, 2012). According to Codex (2017), the limit of PV for virgin oil is at 15 meq/kg because peroxide content presents in the vegetable oils reflects its oxidative level and thus there is a tendency to become rancid. Table 5 shows *Rempeyek* that was packed in aluminium packaging recorded the lowest PV (14.42 meq/g) after 2 months of storage, followed by PET with oxygen absorber (21.96 meq/g), PET (32.35meq/g), LDPE with oxygen absorber (39.55 meq/g) and LDPE (39.75 meq/g). It proves that aluminium is the best packaging among others because fried snack foods should be protected not only from moisture but also from light and oxygen in order to prevent from oxidative rancidity to occur during storage. In addition, this study found that *Rempeyek* stored for 2 months at room temperature can develop peroxide more than 10 meq/g and was classified as high oxidation state.

3.4 Determination of Acid Value (AV)

Acid value (AV) measures the amount of potassium hydroxide (KOH) in gram required to neutralise 1 gram of chemical substance produced from hydrolytic rancidity process, which break the triglycerides into glycerol and free fatty acids. AV that refers to the amount of free fatty acid will increase upon storage due to the continuation of rancidity process. The cleavage of free fatty acid from a parent molecule shows the occurrance of hydrolytic rancidity during the frying process of *Rempeyek*. The higher the AV indicates that the higher hydrolytic rancidity, which contributes to the quality reduction especially the organoleptic properties.

Table 6: Acid Value (mg KOH/g of fat) of *Rempeyek* from different types of packages for 2 months of storage

Packaging materials	**Months of storage**		
	0	1	2
Aluminium	1.51±0.03	1.60±0.03	4.37±0.15
LDPE	1.70±0.03	2.07±0.23	6.17±0.10
LDPE with oxygen absorber	1.71±0.06	1.76±0.03	5.54±0.03
PET	1.56±0.03	1.85±0.03	5.36±0.10
PET with oxygen absorber	1.66±0.03	1.75±0.03	5.21±0.15

Based on Table 6, AV increased upon storage time regardless the materials of packaging used. This is also supported by Jung-Min (2016), who found that the AV of the frying oils increased from 0.47 to 5.14 in soy bean oil, 0.36 to 5.37 in lard, 0.30 to 4.47 in canola oil, and 1.35 to 2.66 in palm oil after 1-101 of frying cycles. Therefore, packaging materials for fried snack also plays an important role in controlling the level of AV upon storage. The AV of *Rempeyek* packed in LDPE was relatively higher (1.70-6.17 mg KOH/g fat) while *Rempeyek* packed in aluminium showed the lowest AV value (1.51-4.37 mg KOH/g fat) compared to other treatments over storage time. These results were in agreement with Abong et al., (2011) who reported that polyethylene bags only maintained the required moisture for up to 16 weeks while aluminium foil pack maintained the moisture level below the maximum limit even after 24 weeks in all storage conditions. Furthermore, after 24 weeks of storage, the accumulated free fatty acid in polyethylene bags was higher than the aluminium foil pack with 1.56% and 1.34% respectively.

3.5 Sensory Analysis using Quantitative Descriptive Analysis (QDA)

QDA is a descriptive sensory test used to describe sensory properties of food products but is not used to measure the level of preference. Table 7 shows the QDA results on the color of *Rempeyek* packed in different packages for 2 months of storage.

Table 7: Color of *Rempeyek* from different types of packages for 2 months of storage

Packaging materials	**Months of storage**		
	0	1	2
Aluminium	8.20±1.09	7.48±2.73	7.88±2.22
LDPE	7.07±1.59	6.55±1.86	7.66±1.85
LDPE with oxygen absorber	8.04±1.27	7.07±1.59	7.09±3.03
PET	8.34±1.52	7.19±2.43	6.55±1.91
PET with oxygen absorber	8.73±1.36	7.12±2.38	6.50±2.30

Color is one of the crucial parameters in the acceptance of food product, especially before it enters the mouth. Appearance or food surface is the first quality parameter evaluated by consumers before other attributes such as taste and texture. In this study, the intensity of color in the scorecard started from weak yellowish-brown to strong yellowish-brown. The results displayed in Table 7 was comparable to the results in Table 4 which measured the b-value (yellowness) by using the instrument. These proved that there is no significant changes in terms of color of *Rempeyek* packed in different packages over 2 months of storage.

All samples scored an acceptable color value from 0 month to 2 months of storage. These findings were supported by Vinothini et al., (2015) who reported that there was no significant color changes of Indian snack food stored in LDPE and Metallised Polyester along 45 days of storage.

Table 8: Aroma of *Rempeyek* from different types of packages for 2 months of storage

Packaging materials	Months of storage		
	0	1	2
Aluminium	8.71±1.20	7.77±2.25	7.12±1.93
LDPE	10.09±0.98	6.71±2.37	6.08±2.67
LDPE with oxygen absorber	8.04±1.54	6.17±2.73	5.88±2.28
PET	8.57±2.12	8.18±2.08	7.65±1.96
PET with oxygen absorber	8.57±1.66	7.59±2.54	7.33±2.45

The aroma of *Rempeyek* was described by using the intensity which started from weak aroma (rancid *Rempeyek*) to strong aroma (fresh *Rempeyek*). The changes of aroma were only significant for *Rempeyek* that was stored in LDPE (10.09 to 6.08) and LDPE with oxygen absorber (8.04 to 5.88) even though Acid Value (AV) and Peroxide Value (PV) showed the development of rancidity from 0 month to 2 months of storage. This shows that consumers will be unable to detect the development of hydroperoxides compound through oxidative rancidity and the effects of hydrolytic rancidity which occurred during storage.

Table 9: Taste of *Rempeyek* from different types of packages for 2 months of storage

Packaging materials	Months of storage		
	0	1	2
Aluminium	7.99±1.72	5.24±3.23	6.51±2.64
LDPE	8.56±0.91	4.39±2.48	5.33±2.89
LDPE with oxygen absorber	8.14±0.87	3.64±2.49	4.44±3.34
PET	8.10±1.15	5.13±3.14	5.92±3.01
PET with oxygen absorber	7.42±1.07	3.71±2.81	5.59±2.25

According to Table 9, consumer will be unable to determine the different tastes in *Rempeyek* stored for 2 months using different packaging methods. However, the *Rempeyek* taste seemed to reduce significantly from 0 month to 1 month of storage in each type of packages. This is parallel to the Peroxide Value and Acid Value, which increased over storage time. Food that was immersed in hot oil with the presence of oxygen exposed the oil to three agents that cause changes in its composition including water from the food (that caused hydrolytic changes), oxygen (that promoted oxidative changes) and high temperature (that caused thermal changes)(Keliani Bordin et al., 2013).

Table 10: Hardness of *Rempeyek* from different types of packages for 2 months of storage

Packaging materials	Months of storage		
	0	1	2
Aluminium	8.78±1.67	6.43±2.81	5.54±2.15
LDPE	7.76±1.47	2.36±1.27	3.11±2.33
LDPE with oxygen absorber	7.27±0.99	3.27±2.45	3.39±2.79
PET	7.83±1.47	5.32±2.71	4.11±2.50
PET with oxygen absorber	7.30±1.28	1.82±1.36	4.35±2.95

Other attribute for QDA analysis is hardness where the intensity starts from the low level of hardness to the higher level of hardness. The hardness of *Rempeyek* was significantly reduced from 0 month to 1 month of storage and the least affected was the *Rempeyek* that was stored in aluminium packaging. This is because aluminium possessed good barrier against the migration of moisture, oxygen and other gases, volatile aroma, and against the impact of light that is generally higher than any plastic laminate material (Lamberti, 2007). On the other hand, QDA results showed that consumers will be unable to determine the hardness changes in *Rempeyek* between different packages especially within the 2 months of storage. Fried banana chips that were packed in LDPE and PP bags respectively showed the development of rancid flavor and loss in crispiness after 30 days of storage (Khanvilkar et al., 2016).

4. Conclusion

In a conclusion, *Rempeyek* that was packed in aluminium packaging showed the best results with lowest Acid Value (4.37 mg KOH/g of fat) and lowest Peroxide Value (14.42 meq/g of oil) since these two parameters referred to the development of rancidity which deteriorated the *Rempeyek* quality during storage. Besides, due to the good barrier towards moisture, light and oxygen, *Rempeyek* stored in aluminium packaging preserved the crispness, taste and aroma as compared to other packaging materials.

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