

## Sensory Characteristics, Acceptability and Proximate Composition Kropeck Made from Waxy and Non-Waxy Maize (*Zea mays L.*)

Quilloy Lisette Ena, P Barrion, Aimee Sheree A\*, Hurtada Wilma A and Dizon Erlinda I

*Institute of Human Nutrition and Food College of Human Ecology, University of the Philippines Los Baños, Los Baños, Philippines*

**\*Corresponding Author:** Aimee Sheree A, Institute of Human Nutrition and Food College of Human Ecology, University of the Philippines Los Baños, Los Baños, Philippines.

**Received:** April 25, 2019; **Published:** November 03, 2020

### Abstract

Utilizing corn as main ingredient for products, snacks in particular, is one way of promoting nutrition. Cereal-based products such as bread, energy bar, flakes, synthetic rice grains, noodles, and crackers are just some of the products that may be formulated through blending or combination of different flours. Likewise in this study, waxy (Lagkitan) and non-waxy corn flours (IPB Var 6 QPM white and IPB Var 11 normal yellow) are combined to produce corn kropeck. The 50:50 ratio was found to be most acceptable for IPB Var 6 Quality Protein Maize (QPM) + Lagkitan in terms of aroma, crispness, and flavor. The 50:50 ratio was also observed to be most acceptable for IPB Var 11 + Lagkitan in terms of appearance and flavor. The general acceptability of the fried IPB Var 6 QPM + Lagkitan kropeck was rated at 5.60 (like to like moderately) while the IPB Var 11 + Lagkitan kropeck obtained a 4.73 score (neither liked nor disliked to like). The fried IPB Var 6 QPM + Lagkitan kropeck yielded significantly higher contents of moisture, crude fat, fiber, protein, and ash than the fried IPB Var 11 + Lagkitan kropeck. No significant difference between the nitrogen free extract the fried IPB Var 11 + Lagkitan kropeck (80.49 %) and the fried IPB Var 6 QPM + Lagkitan kropeck (72.39%). The sensory characteristics of the corn kropeck may already show the aspects that need some improvement Product taste may be enhanced by adding more flavoring close to the taste of corn.

**Keywords:** *Kropeck; Waxy Maize; Non-Waxy Maize; Zea mays*

### Introduction

Cereal and cereal products have been largely part of diet due to humans' basic need for carbohydrates. Some of the cereals have been the staple food of human for basic survival. The Food Staples Sufficiency Program or FSSP of 2011-2016 launched by Department of Agriculture not only focuses on rice but also on corn, kamoteng kahoy, kamote, and saba that may supply energy for typical Filipinos. These other staples are eaten solely or in combination with rice done traditionally in some regions of the Philippines. They are considered important because these are good sources of income for households living in rural and remote areas. They are also beneficial as food energy source for the majority of the population.

Maize is regularly demanded for starch and oil production in the global market. Corn and corn products are important raw materials used in food production. This idea may urge development programs and more agro-biological research for better crop production year round [1]. White corn is being utilized in different parts of the country, specifically Quality Protein Maize (QPM) was developed. QPM is a high-breed flint corn that contains lysine and tryptophan that make the crop acceptable [2]. Waxy maize is another variety utilized, creates numerous possible uses not just in food industry but also in animal nutrition. This is almost similar to subspecies of maize except of its low protein content (Zarate., *et al.* 2004). The normal yellow corn is commonly utilized as snacks or dessert. These three corn cultivars are just a few of many varieties produced anywhere in the world [1].

**Citation:** Quilloy Lisette Ena, *et al.* "Sensory Characteristics, Acceptability and Proximate Composition Kropeck Made from Waxy and Non-Waxy Maize (*Zea mays L.*)". *EC Nutrition* 15.12 (2020): 723-732.

Corn is popularly utilized in different forms or produce in South-East Asian countries and being manufactured up to small scale industry. It has been growing with high market demands that come in different product forms. This now requires scientific understanding of the raw materials and processing or operations needed. One of the corn products manufactured locally is kropeck or cracker. Kropeck is a dried crispy food made from flour, water, and added flavoring. In other South-East Asian countries, kropeck is called "Keropok". This product may have growing market potential since kropeck can be manufactured in small scale. In terms of its nutritional purpose, kropeck may provide a dry product which can be stored and conserved that may provide some nutrients mainly carbohydrates. Its economic significance is that the product can be done in small-scale which can be sold locally in various market [1].

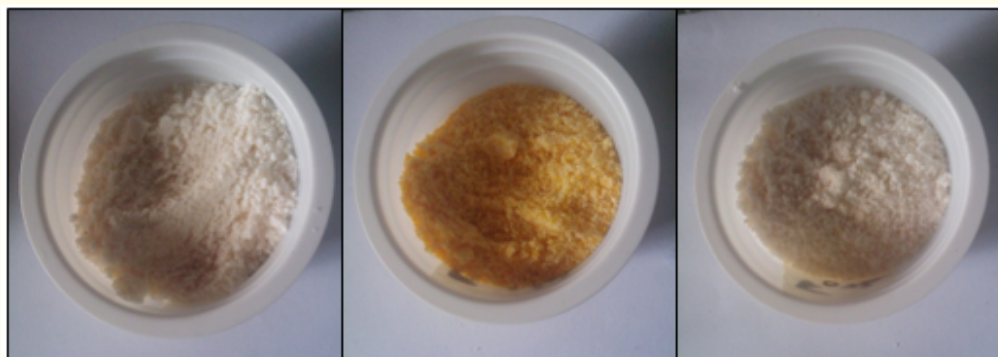
Kropeck is marketable on a wide scale, consumed by any age group. Hence, it would be helpful to enhance its nutritional value. Acceptable kropeck with better sensory qualities is more demanded [1]. Along with product acceptability is consideration of affordability. Kropeck is just one of numerous snacks that consumers would prefer due to practical reasons. People in their work places tend to purchase instant food, ready-to-eat snacks, or easy-to-cook products which may save their limited time. However, people would sometimes skip minding the nutritional values left in processed snacks that were manufactured through different preparation and treatments [3].

For this matter, it is important to understand the effects of raw ingredients and processes that modify the quality of product. Combination of ingredients would be helpful in enhancing some nutrient contents. Enriched snacks may generally be useful in nutrition programs to combat hunger and malnutrition [3]. The study generally aimed to evaluate the sensory characteristics, acceptability and proximate composition of raw and fried corn kropeck made from non-waxy maize (IPB Var 6 QPM and IPB Var 11) and waxy maize (Lagkitan).

## Materials and Methods

### Raw materials

IPB Var 6 QPM white and IPB Var 11 normal yellow, both non-waxy corn flours, and Lagkitan, a waxy corn flour, were used in the study. IPB Var 6 QPM is a white open-pollinated maize. IPB Var 11 is a yellow open-pollinated maize. Lagkitan, also known as Glutinous Composita #2, is a white open-pollinated waxy maize. All flours were authenticated and procured from Institute of Plant Breeding at the University of the Philippines Los Baños (UPLB), College Laguna.



**Figure 1:** Corn flours used in kropeck (A – IPB Var 6 QPM; B – IPB Var 11; C – Lagkitan).

### Preparation of corn kropeck

The procedure in corn kropeck making was adopted from Food Processing Division ITDI (DOST-FNRI) methods. To make the kropeck batter, 720 mL water was added to 300 grams of corn flour. The batter was mixed well using a blender to remove lumps. One teaspoon or 5 grams of salt and ½ teaspoon or 2.5 grams of MSG were added. After thorough mixing, the batter was transferred to a greased aluminum

pan. It was steamed for 10 minutes and then cooled to room temperature. Steamed batter was sliced into rectangular pieces then placed into another aluminum pan layered with polyethylene plastic film. Then it was oven-dried at 50°C overnight. Finished product was fried in cooking oil for 1 minute at 110°C.

### Preliminary study

#### Sensory evaluation of kropeck with different flour blend ratios

Corn kropecks made from different corn flour blend ratios i.e. 100:0, 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80, 10:90 and 0:100 were evaluated in terms of their sensory attributes namely appearance, color, aroma, texture, crispness, flavor, and general acceptability using 7-point hedonic scale. Thirty (30) panelists from Putho, Los Baños Laguna, consisting of 15 males and 15 females who were 19 to 52 years old, evaluated the samples. The kropeck from IPB Var 6 QPM + Lagkitan flour mixture and the kropeck from IPB Var 11 + Lagkitan flour mixture with the highest mean sensory attribute and acceptability scores were further analyzed for their nutritive and health values.

### Chemical analyses

The most acceptable kropeck mixture treatments i.e. 50:50 IPB Var 6 + Lagkitan and 50:50 IPB Var 11 + Lagkitan were further analyzed for their nutritive and health values. All samples were analyzed in triplicates at dry weight basis. The proximate analysis, carbohydrate profile analysis, phytochemical tests, and antioxidant capacity test followed the procedures as described in the Association of Official Agricultural Chemists or AOAC International Methods [4].

### Proximate analysis

#### Moisture analysis

Ten grams of sample were placed in a moisture dish subjected to oven at 45 °C overnight. After drying, sample was placed in a desiccator to equilibrate its temperature [4]. Finally, sample was weighed and the moisture content was computed using the following formula:

$$\% \text{ Moisture} = \frac{(\text{Fresh weight in grams} - \text{Dry weight in grams})}{\text{Fresh weight in grams}} \times 100$$

#### Crude fat analysis

One gram of sample was placed in paper thimble, stapled at each end. Thimbles were placed in a soxhlet fat extractor. Hexane was added to the boiling flask connected to the defatting set-up. Sample was defatted for 12 hours. Thimbles were dried in oven for 1 hour at 45°C, then temperature was equilibrated in a desiccator [4]. The crude fat was computed using the following formula:

$$\% \text{ Crude Fat} = \frac{\text{Weight of fats in grams}}{\text{Weight of sample in grams}} \times 100$$

#### Crude fiber analysis

Hundred milligrams of defatted sample was obtained in a 100 mL Bercillus beaker. Fifty milliliters of 2.5% sulfuric acid was added then solution was subjected to reflux for 30 minutes. The fiber contents were transferred to filter paper then washed with hot water until washings turned neutral with litmus paper. Washed fibers were transferred back to the Erlenmeyer flask added with 50 mL of 2.5% Sodium hydroxide. Solution was refluxed for 30 minutes. Fiber contents were finally placed on Whatman filter paper, washed again until it has reached neutral pH. Filter paper was placed on gooch crucibles then oven-dried at 105°C for 1 hour. After drying, samples were placed in furnace overnight at 550°C. After drying, samples were cooled in a desiccator then finally weighed [4]. The following formula was used in computing the crude fiber content:

$$\% \text{ Crude Fiber} = \frac{\text{Weight of fiber in grams}}{\text{Weight of sample in grams}} \times 100$$

### Crude ash content analysis

One gram of dried sample was obtained. Sample was placed in a 30 mL porcelain crucible tared on analytical balance. Using a furnace, sample was ignited at 550°C overnight. Crucibles were next transferred to a desiccator. Upon reaching room temperature, samples were weighed [4]. The ash content was computed using the following formula:

$$\% \text{ Crude Ash} = \frac{\text{Weight of ash in grams}}{\text{Weight of sample in grams}} \times 10$$

### Crude protein analysis using nitrogen colorimetry method

Fifty milligrams of dried powdered sample were obtained in a 30 mL digestion flask. Next added was 0.5 g of selenium catalyst mixture followed by 2 mL of sulfuric acid. Digestion flasks were subjected to microdigestor for 30 minutes until solution turned clear. Sample was cooled and transferred quantitatively into test tube. Using volumetric flask, sample was diluted to 10 mL with distilled water. Aliquot was taken from each sample added with 1.5 mL of working buffer. Next added was 0.4 mL of salicylate reagent followed by 0.2 mL of hypochlorite solution (NaClO). Test tubes were shaken then left standing for 30 minutes to develop color. Finally, sample was diluted to 10 mL with distilled water. Absorbance reading was obtained at 660nm. A standard curve was prepared using ammonium sulfate. Salt was digested same as the procedure used in sample analysis. The digest was diluted with distilled water to a final volume of 100 mL. Absorbance reading of the diluted salt was also obtained at 660 nm which values were used to compute for the slope of the standard [4]. The crude protein content derived from nitrogen content was computed using a standard formula:

$$\% \text{ Nitrogen} = \frac{\text{Slope standard} \times \text{Absorbance sample} \times 100}{\text{Weight of sample in mg}}$$

$$\% \text{ Protein} = \text{Nitrogen (\%)} \times 6.25 \text{ constant}$$

Where:

$$\text{Slope standard} = \text{ug Nitrogen/unit absorbance}$$

$$6.25 = \text{Cereal constant}$$

### Statistical analysis

One-way Analysis of Variance (ANOVA) was used to evaluate the significant differences of the sample treatments in terms of proximate composition. Duncan's Multiple Range Test (DMRT) was used to evaluate the significant differences of sensory attributes among the samples. Spearman Rank Correlation Test was used to determine the degree of association between sensory attributes and general acceptability of the samples.

## Results and Discussion

### Preliminary study

#### Sensory evaluation of corn kropeck

The preliminary study showed that among the corn flour mixtures used i.e. 100:0, 90:10, 80:20 70:30, 60:40, 50:50, 40:60, 30:70, 20:80, 10:90, and 0:100, the most acceptable flour mixture ratio of IPB Var 6 QPM to Lagkitan was 50:50 (Table 1) while that of IPB Var 11 to Lagkitan was 50:50 (Table 2). The 50:50 ratio was found to be most acceptable for IPB Var 6 QPM + Lagkitan in terms of aroma, crispness, and flavor as manifested by highest score. On the other hand, the 50:50 ratio was observed to be most acceptable for IPB Var 11 + Lagkitan in terms of appearance and flavor as also evaluated with the highest score.

Product quality can be assessed through sensory attributes. Sensory evaluation is a measuring tool for product characteristics and over-all acceptability. Physical attributes such as color, shape and size, as well as properties related to texture and consistency all entail person's feedback to the food [5].

Sample IPB Var 6: Lagkitan	Sensory Attributes						General Accept-Ability
	Appearance	Color	Aroma	Texture	Crispness	Flavor	
100:0	4.57 ± 1.7	5.00 ± 1.7	4.53 ± 1.7 <sup>f</sup>	4.40 ± 1.4 <sup>e</sup>	4.33 ± 1.3 <sup>b</sup>	4.57 ± 1.7 <sup>g</sup>	4.33 ± 1.8 <sup>f</sup>
90:10	4.57 ± 1.7	5.47 ± 1.6	4.53 ± 1.7 <sup>b</sup>	5.17 ± 1.9 <sup>b</sup>	3.53 ± 1.3 <sup>c</sup>	4.57 ± 1.7 <sup>c</sup>	4.33 ± 1.8 <sup>c</sup>
80:20	4.73 ± 1.8	4.47 ± 1.5	4.17 ± 1.4 <sup>d</sup>	3.77 ± 1.4 <sup>d</sup>	4.07 ± 1.3 <sup>e</sup>	3.97 ± 1.3 <sup>d</sup>	4.23 ± 1.4 <sup>f</sup>
70:30	4.47 ± 1.6	4.87 ± 1.5	5.00 ± 1.6 <sup>b</sup>	4.20 ± 1.3 <sup>c</sup>	4.03 ± 1.3 <sup>d</sup>	5.00 ± 1.8 <sup>c</sup>	4.57 ± 1.8 <sup>c</sup>
60:40	5.07 ± 1.6	4.60 ± 1.1	4.30 ± 1.6 <sup>e</sup>	3.83 ± 1.5 <sup>e</sup>	3.87 ± 1.3 <sup>f</sup>	3.80 ± 1.4 <sup>b</sup>	4.30 ± 1.4 <sup>e</sup>
50:50	4.50 ± 1.6	5.00 ± 1.7	5.63 ± 1.8 <sup>a</sup>	4.40 ± 1.4 <sup>c</sup>	5.23 ± 1.8 <sup>a</sup>	5.03 ± 1.8 <sup>a</sup>	5.60 ± 1.5 <sup>b</sup>
40:60	4.73 ± 1.8	5.07 ± 1.6	4.83 ± 1.5 <sup>f</sup>	4.40 ± 1.6 <sup>a</sup>	4.23 ± 1.5 <sup>d</sup>	4.40 ± 1.5 <sup>g</sup>	4.60 ± 1.5 <sup>g</sup>
30:70	5.07 ± 1.6	4.73 ± 1.8	4.67 ± 1.4 <sup>e</sup>	4.07 ± 1.3 <sup>d</sup>	3.77 ± 1.4 <sup>c</sup>	4.40 ± 1.5 <sup>e</sup>	4.60 ± 1.5 <sup>a</sup>
20:80	5.00 ± 1.7	4.60 ± 1.8	4.93 ± 1.7 <sup>e</sup>	4.43 ± 2.0 <sup>f</sup>	4.80 ± 1.7 <sup>f</sup>	5.00 ± 1.8 <sup>f</sup>	4.57 ± 1.8 <sup>g</sup>
10:90	4.57 ± 1.7	4.60 ± 1.1	4.30 ± 1.4 <sup>e</sup>	3.73 ± 1.2 <sup>d</sup>	3.40 ± 1.3 <sup>d</sup>	4.13 ± 1.7 <sup>d</sup>	4.30 ± 1.4 <sup>d</sup>
0:100	5.00 ± 1.7	5.03 ± 1.7	4.83 ± 1.5 <sup>f</sup>	4.87 ± 1.7 <sup>f</sup>	4.67 ± 1.8 <sup>g</sup>	4.70 ± 1.5 <sup>e</sup>	4.67 ± 1.3 <sup>d</sup>
P-value	0.802 <sup>NS</sup>	0.322 <sup>NS</sup>	0.010	0.001	0.001	0.002	0.006

**Table 1:** Sensory evaluation for Kropeck made from IPB Var 6 QPM and Lagkitan flour blend ratios.

\*Values are expressed as Mean ± SD for the samples. In a column, values not sharing common superscript differ significantly at  $p < 0.05$ ; NS – not significant

\*Scale: 1=Dislike much, 2=Dislike moderately, 3=Dislike, 4=Neither, 5=Like, 6=Like moderately, 7=Like much.

\*IPB Var 6 QPM – white corn; Lagkitan – glutinous white corn.

Sample IPB Var 11: Lagkitan	Sensory Attributes						General Accept-Ability
	Appearance	Color	Aroma	Texture	Crispness	Flavor	
100:0	4.60 ± 1.8	4.57 ± 1.7	4.72 ± 1.5	4.37 ± 1.8 <sup>d</sup>	4.20 ± 1.5 <sup>a</sup>	4.43 ± 1.8 <sup>f</sup>	4.20 ± 1.5 <sup>a</sup>
90:10	4.60 ± 1.8	4.57 ± 1.7	4.67 ± 1.5	4.37 ± 1.8 <sup>d</sup>	3.83 ± 1.5 <sup>d</sup>	3.83 ± 1.5 <sup>d</sup>	4.20 ± 1.3 <sup>e</sup>
80:20	4.83 ± 1.7	4.90 ± 1.5	4.77 ± 1.5	4.23 ± 1.5 <sup>c</sup>	4.07 ± 1.7 <sup>b</sup>	4.03 ± 1.5 <sup>c</sup>	4.57 ± 1.6 <sup>b</sup>
70:30	4.87 ± 1.5	4.50 ± 1.6	4.80 ± 1.5	3.87 ± 1.3 <sup>e</sup>	4.00 ± 1.8 <sup>e</sup>	3.97 ± 1.2 <sup>e</sup>	4.37 ± 1.4 <sup>f</sup>
60:40	4.70 ± 1.5	4.83 ± 1.7	4.63 ± 1.8	4.57 ± 1.7 <sup>b</sup>	4.20 ± 1.8 <sup>c</sup>	4.70 ± 1.7 <sup>g</sup>	4.70 ± 1.8 <sup>d</sup>
50:50	5.03 ± 1.7	4.47 ± 1.5	4.17 ± 1.4	4.80 ± 1.7 <sup>a</sup>	4.07 ± 1.9 <sup>f</sup>	4.97 ± 1.8 <sup>c</sup>	4.73 ± 1.6 <sup>c</sup>
40:60	4.67 ± 1.1	4.70 ± 1.8	4.70 ± 1.8	4.90 ± 1.8 <sup>f</sup>	4.17 ± 2.1 <sup>d</sup>	4.73 ± 1.9 <sup>b</sup>	4.67 ± 2.0 <sup>c</sup>
30:70	4.60 ± 1.1	5.07 ± 1.6	4.83 ± 1.5	4.47 ± 1.5 <sup>f</sup>	4.40 ± 1.6 <sup>f</sup>	3.97 ± 1.3 <sup>f</sup>	4.23 ± 1.4 <sup>g</sup>
20:80	4.33 ± 1.6	5.03 ± 1.7	4.53 ± 1.7	4.37 ± 1.8 <sup>c</sup>	4.30 ± 1.8 <sup>g</sup>	4.57 ± 1.8 <sup>e</sup>	4.33 ± 1.8 <sup>b</sup>
10:90	4.73 ± 1.8	4.73 ± 1.6	4.33 ± 1.3	4.23 ± 1.5 <sup>d</sup>	4.43 ± 2.0 <sup>b</sup>	3.80 ± 1.4 <sup>a</sup>	3.83 ± 1.4 <sup>f</sup>
0:100	5.00 ± 1.7	5.03 ± 1.7	4.83 ± 1.5	4.87 ± 1.7 <sup>g</sup>	4.67 ± 1.8 <sup>f</sup>	4.70 ± 1.5 <sup>g</sup>	4.67 ± 1.3 <sup>e</sup>
P-value	0.835 <sup>NS</sup>	0.374 <sup>NS</sup>	0.768 <sup>NS</sup>	0.008	0.002	0.002	0.003

**Table 2:** Sensory evaluation for Kropeck made from IPB Var 11 and Lagkitan flour blend ratios.

\*Values are expressed as Mean±SD for the samples. In a column, values not sharing common superscript differ significantly at  $p < 0.05$ ; NS – not significant

\*Scale: 1=Dislike much, 2=Dislike moderately, 3=Dislike, 4=neither, 5=Like, 6=Like moderately, 7=Like much.

\*IPB Var 11 – normal yellow corn; Lagkitan – glutinous white corn.

There were significant differences in the mean scores of appearance, texture, and flavor across the samples (Table 1 and 2). Based on the mean sensory evaluation scores, all treatments mixed with *Lagkitan* flour had scores higher than 4, indicating that panelists accepted the mixture of waxy and non-waxy corn flours for kropeck.

The appearance of the kropeck products was significantly different across the samples. This may be due to different degrees of browning that each product has obtained. Frying mainly changed the appearance of kropeck products, which obviously manifested in color of the finished product. Waxy type flours promote puffed appearance [6], hence kropeck made from waxy maize flour had the most acceptable appearance.

Texture was a significant attribute across the kropeck samples. This trait was related to crispness according to the evaluators. The changes in texture normally manifest as pores that are formed by evaporation of water. High temperature, often exerted as intense heat, causes explosion that would create wide pores on the surface of food. From here, crust is immediately formed which acts as a corresponding barrier to further evaporation. This generally causes water loss. Formation of pores is also accompanied by expansion of product size during frying. These manifestations consequently affect the general acceptability of product [7].

The flavor was another significant attribute affected by the browning reactions and frying. Flavor may also be affected by moisture, protein, and fat contents of the food. Proteins participate in the Maillard and other browning reactions. These chemical reactions cause the decomposition of amino acids which are the building blocks of proteins. Eventually, the browning reaction leads to manifestation of brown pigments which may define the flavor of food together with odor compounds [8].

The IPB Var 11+*Lagkitan* (50:50) kropeck turned darker than the IPB Var 6 QPM + *Lagkitan* (50:50) kropeck. The changes in the surface of kropeck may have been caused by Maillard or non-enzymatic browning reaction that actually develops the golden brown color hues of fried food. It also causes evaporation of water resulting in crust formation and crisp texture of food. During frying, this reaction is being achieved as soon as temperature of oil reaches approximately 110°C [7].

The cooking oil acted as an important factor that affects the sensory characteristics of the kropeck. This cooking element is responsible in enhancing and releasing the flavor of the kropeck ingredients. The main effect of frying is that it makes the product more acceptable and edible. Cooking oil acts as a palatable agent absorbed by the raw food that makes it crusty [9].

Results showed that all sensory attributes had significant moderate positive correlation to the general acceptability of the products (Table 3). Furthermore, the flavor with coefficient value of 0.66 was strongly positively related to general acceptability. Flavor is an important attribute in the panelists' acceptability rating of a product [10]. It indicates that flavor was the strongest factor affecting the general acceptability of corn kropecks. The appearance depends on how panelists see the outer characteristics of the product. It generally affects the acceptability of food. Color is considered important attribute that affects sensory perception. Aroma is also considered a determinant of product acceptability [11]. Texture is an important sensory attribute contributive to acceptability. It is related to physical properties of the product that affects consumer acceptance (Pereira, *et al.* 2013). Crispness, described as crunchiness, is a distinct property that affects overall acceptance of a product [11].

### **Proximate composition of corn flour**

The contents of moisture, protein, and ash were found highest in IPB Var 6 QPM flour. The *Lagkitan* maize flour had the highest fat and Nitrogen-free extract (NFE) contents. The IPB Var 11 flour had the highest fiber contents among the three corn flours (Table 4). Significant differences were observed only in moisture, fat, and fiber contents.

The moisture content of the corn flours depends on the granular structure of the raw material. The compact structure of amylose network may interfere with the leaching of moisture [12].



Sensory Attribute	Coefficient (P)	Degree of Correlation	Significance Level
Appearance	0.5077	Moderate	0.001
Color	0.5539	Moderate	0.001
Aroma	0.5046	Moderate	0.001
Texture	0.5325	Moderate	0.001
Crispness	0.5353	Moderate	0.001
Flavor	0.6635	Strong	0.001

**Table 3:** Correlation of sensory attributes to general acceptability.

Note: Degree of correlation 0.00-0.19 = very weak, 0.20-0.39 = weak, 0.40-0.59 = moderate, 0.60-0.79 = strong, 0.80-1.00 = very strong.

Corn Flour	Moisture (%)	Crude Fat (%)	Crude Fiber (%)	Crude Protein (%)	Crude Ash (%)	Nitrogen Free Extract
IPB Var 6 QPM	2.65 ± 0.05 <sup>b</sup>	2.33 ± 0.60 <sup>a</sup>	3.30 ± 0.10 <sup>a</sup>	11.70 ± 0.84	1.11 ± 0.03	78.91 ± 1.50
IPB Var 11	2.35 ± 0.05 <sup>b</sup>	3.10 ± 0.30 <sup>b</sup>	3.62 ± 0.04 <sup>b</sup>	9.49 ± 1.86	0.83 ± 0.58	80.61 ± 2.42
Lagkitan	1.43 ± 0.31 <sup>a</sup>	4.72 ± 0.33 <sup>b</sup>	1.26 ± 0.02 <sup>b</sup>	8.78 ± 0.94	1.04 ± 0.04	82.77 ± 1.12
F-value	36.77	23.75	1153.19	4.15	0.56	3.59
P<0.05	0.000	0.001	0.000	0.074 <sup>NS</sup>	0.601 <sup>NS</sup>	0.095 <sup>NS</sup>

**Table 4:** Proximate composition of different corn flours (dry weight basis).

Note: Values are expressed as Mean ± SD for the three samples. In a column, values not sharing common superscript differ significantly at  $p < 0.05$  (DMRT); NS – not significant.

\*IPB Var 6 QPM – white corn; IPB Var 11 – normal yellow corn; Lagkitan – glutinous white corn.

The yield of crude fat from waxy cereal grains is greater than that of non-waxy [13]. Similarly, Aini., *et al.* [14] mentioned that crude fat content of waxy maize flour is higher than that of non-waxy maize flour.

The integral protein of starch is granule-bound starch synthase which is responsible for production of amylose, hence, the waxy corn flour has lower content of protein [15]. The protein content contributes to hard texture of product because of the rigid network built between protein molecules [16].

The ash represents the minerals mostly found in the aleurone layer of the cereal grain. These minerals are uniformly distributed in the grain. Once cereal grains are processed into flour, the minerals tend to diminish in quantity. Non-waxy corn cultivar usually contains a bit higher contents of ash compared to waxy corn cultivar [17].

The crude fiber contents may be inversely compared to carbohydrates or Nitrogen-free extract (NFE) computed values. Since corn flour is composed of majority of digestible starches, it would have high contents of carbohydrates. Therefore, the indigestible portion or the crude fiber content would be low (Palana 2008).

### Proximate Composition of Corn Kropeck

The raw IPB QPM Var 6 + *Lagkitan kropeck* resulted in higher contents of crude fat, crude fiber, protein, and ash than IPB Var 11 + *Lagkitan kropeck* which exhibited higher contents of moisture and NFE. Fried IPB Var 6 QPM + *Lagkitan kropeck* yielded higher contents of moisture, crude fat, fiber, protein, and ash (Table 5).

Corn Kropeck	Moisture (%)	Crude Fat (%)	Crude Fiber (%)	Crude Protein (%)	Crude Ash (%)	Nitrogen Free Extract (%)
<b>Raw</b>						
IPB Var6 ± <i>Lagkitan</i> (50:50)	2.20 ± 0.10 <sup>a</sup>	4.10 ± 1.49 <sup>c</sup>	2.51 ± 0.05	11.74 ± 0.60 <sup>a</sup>	1.07 ± 0.58	78.38 ± 1.88
IPB Var11 ± <i>Lagkitan</i> (50:50)	2.50 ± 0.00 <sup>b</sup>	4.07 ± 2.04 <sup>c</sup>	2.42 ± 0.08	9.68 ± 1.58 <sup>b</sup>	1.01 ± 0.02	80.32 ± 3.28
<b>Fried</b>						
IPB Var6 ± <i>Lagkitan</i> (50:50)	0.10 ± 0.00 <sup>c</sup>	14.43 ± 5.60 <sup>a</sup>	2.42 ± 0.01	9.68 ± 1.82 <sup>c</sup>	0.97 ± 0.11	72.39 ± 7.32
IPB Var11 ± <i>Lagkitan</i> (50:50)	0.05 ± 0.05 <sup>c</sup>	10.57 ± 1.57 <sup>b</sup>	2.41 ± 0.09	5.54 ± 1.76 <sup>c</sup>	0.93 ± 0.09	80.49 ± 3.53
F-value	1671.00	7.69	2.40	8.77	0.12	2.13
P < 0.05	0.00	0.01	0.14 <sup>NS</sup>	0.007	0.95 <sup>NS</sup>	0.175 <sup>NS</sup>

**Table 5:** Proximate composition of raw and fried corn kropeck (dry weight basis).

Note: Values are expressed as Mean ± SD for the four samples. In a column, values not sharing common superscript differ significantly at  $p < 0.05$  (DMRT); NS – not significant.

\*IPB Var 6 QPM – white corn; IPB Var 11 – normal yellow corn; *Lagkitan* – glutinous white corn.

The significant loss of moisture has occurred due to high temperature applied during frying. Moisture loss is basically caused by the frying process making the moisture leak or evaporate while heat and fat penetrate the food [18].

Fat contents significantly increased due to the addition of cooking oil used in frying in all samples. The process begins with transfer of heat from the cooking oil to the surface of food through convection. Then, the heat next penetrates the center of the food which is through conduction. The available moisture begins to evaporate leading to development of crust. Capillary pores are formed which expand during frying. After frying, the surface tension between the oil and gas widens at decreasing temperature. This causes increase in capillary pressure which attracts oil to enter the pores of the food (Hui, *et al.* 2006).

The significant decrease in crude protein of both kropecks was observed after frying. Heat treatment may change the nutritive value or the amount of protein which may also change the composition of protein in food [7]. Essentially, proteins participate in Maillard and browning reactions that occur in frying. These reactions cause the decomposition of amino acids which are basically the building blocks of proteins. This may now have caused the significant decrease in protein content [8].

Crude fiber had the same trend with moisture and protein. A reduction in fiber contents may occur. However, crude fiber was not significantly affected by frying. There may have minimal changes on the fiber contents when product was fried. Fibers are basically resistant to heat [19].

In terms of ash contents, no significant difference was observed from the two kropecks after frying. The minerals are slightly affected by frying at high temperatures and short cooking time [7].

Any thermal, industrial, or culinary process such as frying may change the nutritive value of a processed food. The composition of food is selectively being modified when oil enters the contents of food being fried. Nonetheless, the changes in calculated NFE or carbohydrate values of both kropecks were not significant. This indicates that there may be factors affecting NFE other than the proximate contents [9,20-23].

## Summary and Conclusion

Corn flour from waxy corn *Lagkitan* was mixed to non-waxy corn flours IPB Var 6 QPM and IPB Var 11 to come up with eleven corn flour blends for the production of corn kropeck. Based on the sensory evaluation in preliminary study, 50:50 flour ratio was most acceptable. Hence, 50:50 flour ratio was used in making the two kropecks for the succeeding study. The flavor of kropeck was strongly positively



correlated to the general acceptability. Other sensory attributes such as appearance, color, aroma, texture, and crispness were all moderately positively correlated to the general acceptability of the product.

The IPB Var 6 QPM + *Lagkitan kropeck* had higher contents of crude fat, crude fiber, crude protein, and crude ash than IPB Var 11 + *Lagkitan kropeck*. After frying, there was significant decrease in contents of moisture and crude protein.

## Bibliography

1. Taewee TK. "Cracker "Keropok": A review on factors influencing expansion". *International Food Research Journal* 18.3 (2011): 855-866.
2. Panlasigui LN., et al. "Research Article: Glycaemic Response to Quality Protein Maize Grits". *Journal of Nutrition and Metabolism* (2010): 1-6.
3. Otunola ET., et al. "Effects of Addition of Partially Defatted Groundnut Paste on Some Properties of 'Kokoro' (a popular snack made from maize paste)". *Agriculture and Biology Journal of North America* 3.7 (2012): 280-286.
4. The Official Methods of Analysis of The Association of Official Analytical Chemists. 1990. Association of Official Analytical Chemists USA (1990).
5. Nagares NC., et al. "Nutritional Value, Physicochemical Properties, and Acceptability of Rice (*Oryza sativa L.*) Composite". *The Asian International Journal of Sciences* 20.1 (2011): 199-214.
6. Pichetnawin T. "Effect of Modified Starches on Quality Attributes of Rice Cracker". Silpakorn University. Thailand. MSc. Thesis (2004): 2-3.
7. Bordin K., et al. "Changes in Food Caused by Deep Fat Frying". *Archivos Latino Americanos De Nutricion* 63.1 (2013): 5-13.
8. Fetuga GO., et al. "Effect of Frying Temperature and Time on Composition and Sensory Quality of Sweet Potato Crisps". A Research Article in African Journal of Root and Tuber Crops. Nigeria. 11.1 (2014): 17-25.
9. Ghidurus M., et al. "Nutritional and Health Aspects Related to Frying (I)". Romanian Biotechnological Letters. University of Bucharest. Romania. 15.6 (2010): 5675-5682.
10. Razzaq MR., et al. "Effect of Temperature, Screw Speed and Moisture Variations on Extrusion Cooking Behavior of Maize (*Zea mays L.*)". *Pakistan Journal of Food Sciences* 22.1 (2012): 12-22.
11. Tortoe C., et al. "Evaluation of The Sensory Characteristics and Consumer Acceptability of Deep-fried Yam (*Dioscorea rotundata*) Crisps in the Accra Metropolitan Area". *Journal of Food and Nutrition Sciences*. 2.1 (2014): 19-23.
12. Lin JH., et al. "Influence of Moisture Content on The Degradation of Waxy and Normal Corn Starches Acid-treated in Methanol". *Food Hydrocolloids* 26.2 (2012): 370-376.
13. Cameron DK And Wang YJ. "A Better Understanding of Factors That Affect the Hardness and Stickiness of Long-Grain Rice". *American Association of Cereal Chemists* 82.2 (2005): 113-119.
14. Aini N., et al. "Characteristics of White Corn Noodles Substituted by Tempeh Flour". *Jouranl Teknol da Industri Pangan*. Jakarta, Indonesia 23.2 (2012): 179-185.
15. Jiranuntakul W., et al. "Microstructural and Physicochemical Properties of Heat-moisture Treated Waxy and Normal Starches". *Journal of Food Engineering* 104.2 (2011): 246-258.
16. Shukri R. "Effects of Amylose Content and Chemically Cross-linking Starch on In-vitro Digestibility and Extrusion of Starch". Putra Malaysia. PhD. Thesis (2006): 106-107.
17. Jayakody JLP. "The Effect of Acid Hydrolysis on Granular Morphology and Physicochemical Properties of Native Starch Granules". Acquisitions and Bibliographic Services. Canada. MSc. Thesis (2001): 33-34.

18. Shanita SK., *et al.* "Amylose and Amylopectin in Selected Malaysian Foods and its Relationship to Glycemic Index". *Sains Malaysiana* 40.8 (2011): 865-870.
19. Abong GO., *et al.* "Nutrient Contents of Raw and Processed Products from Kenyan Potato Cultivars". *Journal of Applied Biosciences* 16 (2009): 877-886.
20. The Fao Food and Nutrition Paper. Food and Agriculture Organization of the United Nations, (2008).
21. [www.da.gov.ph/index.php/2012-03-27-12-03-56/2012-04-13-12-38-36](http://www.da.gov.ph/index.php/2012-03-27-12-03-56/2012-04-13-12-38-36)
22. Food Staples Sufficiency Program (Enhancing Agricultural Productivity and Global Competitiveness 2011-2016).
23. FAO CORPORATIVE DOCUMENT REPOSITORY: Fermented Cereals. Global perspective. Agriculture and Consumer Protection.

**Volume 15 Issue 12 December 2020**

**©All rights reserved by Aimee Sheree A., *et al.***