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# Characteristics of *Mocaf* cookies with the Addition of *Mucuna pruriens* and *Cucurbita moschata* as a Healthy cookies Alternative

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**Abstract.** The utilization of *Mucuna pruriens* flour and pumpkin in the preparation of *mocaf* cookies offers an alternative means of producing a nutritionally dense baked good, characterized by its high fiber and protein content. This study aims to predict the morphological structure and functional groups of *mocaf* cookies with the addition of *Mucuna pruriens* flour and pumpkin as an alternative raw material rich in nutrients. This study employs an experiment design, specifically the Complete Randomized Block Design (RAKL) Factorial method with two replications. The data were subjected to Analysis of Variance (ANOVA) to ascertain the impact of the treatment and subsequently analyzed using the Duncan Multiple Range Test (DMRT) at the 5% level. The morphological profile of the cookies structure was examined using a Scanning Electron Microscope (SEM), while the functional groups were analyzed with a Fourier transform infrared (FTIR) spectrometer. The morphological structure of the *mocaf* cookies, as observed under SEM, exhibited a composition of 52% carbon (C) atoms and 48% oxygen (O) atoms. The FTIR spectroscopy analysis revealed that the addition of *Mucuna pruriens* and pumpkin to the *mocaf* cookies resulted in the formation of general olefin functional groups at a temperature of 120°C.

## 1. Introduction

Velvet beans (*Mucuna pruriens* L.) is one of beans with high protein content that has the potential as a source of bioactive peptides so that velvet bean can be used as a potential antihypertensive functional food ingredient [1]. Velvet beans contain various nutrients that are hypocholesterolemic such as niacin, fiber, isoflavones, phenols, and saponins [2]. Velvet beans have the potential to be used as a food substitute or a total protein-based food replacement. The color characteristics of *mocaf* cookies with the addition of velvet beans flour will tend to be dark so pumpkin needs to be added.

Pumpkin as a food ingredient is rich in dietary fiber, especially pectin, bioactive compounds, beta-carotene, vitamin A, thiamine, riboflavin, other vitamins such as B6, K, C, and other types of minerals such as K, P, Mg, Fe, and Se [3]. Pumpkin contains carotenoid compounds and beta-carotene compounds that act as antioxidants in the human body. The addition of pumpkin flour can increase antioxidant activity in food products [4]. Pumpkin contains high fiber, so it helps maintenance digestive health [5].

To find out the functional properties of *mocaf* cookies, it is necessary to know the morphological structure and functional groups. This is related to the fundamental characteristics of a substance that plays a role in determining the physical and chemical properties of food ingredients. The purpose of this study was to predict the morphological structure and functional groups of *mocaf* cookies with the



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addition of velvet beans flour and pumpkin so that an initial picture of the composition of the ingredients that will affect the sensory acceptance of panelists was obtained. *cookies* are cooked at drying temperatures of 110°C and 120°C to determine the morphological and functional group changes in the *cookies* compound.

## 2. Materials and methods

This study was arranged in a Randomized Complete Block Design (RCBD) Factorial with two replications, consisting of two factors. The first factor is ratio/proportion of velvet bean and pumpkin consisting of six variations: 60:10 (F1), 50:20 (F2), 40:30 (F3), 30:40 (F4), 20:50 (F5), and 10:60 (F6). The second factor is the difference in drying temperature, namely 110°C (T1) and 120°C (T2). The combination of experiments is presented in Table 1.

**Table 1.** Combination of Experimental Designs in Research

Addition of velvet beans and pumpkin (F)	Temperature Variation (°C)	
	T1(110)	T2(120)
F1 (60:10)	T1F1	T2F1
F2 (50:20)	T1F2	T2F2
F3 (40:30)	T1F3	T2F3
F4 (30:40)	T1F4	T2F4
F5 (20:50)	T1F5	T2F5
F6 (10:60)	T1F6	T2F6

The tools used in making *mocaf cookies* include scales (Acis AD-300i), a cabinet dryer (Memmert IN 110), a mixer (Philip), and an oven (Bolde). The main raw materials of the study include ingredients for making *cookies*, namely Point brand *mocaf* flour, velvet beans from Kulonprogo farmers, old pumpkin with a diameter of 20 cm weighing  $\pm$  1-2 kg, margarine, eggs, vanilla, sugar, salt, baking soda, and skim milk.

Selected pumpkin velvet beans flour *mocaf cookies* testing equipment from 110°C and 120°C treatments:

- FTIR Thermo Scientific Nicolet iS10  
 Detector Type : Deuterated TriGlycine Sulfate (DTGS)  
 Accessories : Smart Omni Transmission
- SEM JEOL\_JSM\_6510  
 Detector Type : SEI

### 2.1. Processing Procedure

The research began with the process of making velvet beans flour, which included soaking velvet beans seeds for 3 days with water changes every 12 hours[6]. After being drained, the velvet beans seeds were skinned and dried in a cabinet dryer at a temperature of 50°C for 3 days. The dried velvet beans seeds were then ground until they passed through an 80-mesh sieve. Velvet beans contain anti-nutritional compounds that can be limited by processing methods such as boiling, soaking, and peeling the skin[7]. The preparation of pumpkin begins by peeling the skin of the pumpkin, separating the seeds, and then grating the flesh.

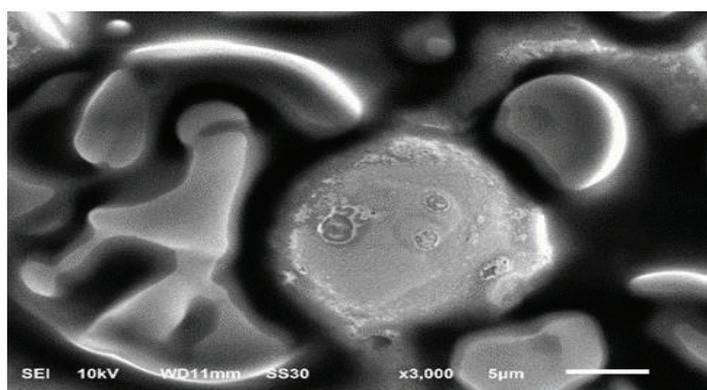
## 2.2. Cookies Formulation

The cookies were made by mixing 38% (w/w) margarine, 1.5% (w/w) baking soda, 1% (w/w) salt, 53% (w/w) granulated sugar, and 3% (w/w) skim milk using a mixer on low speed. After mixing, vanilla and eggs are added, and finally, *mocaf* flour, velvet beans flour, and grated pumpkin were added. Stirring was done using a mixer until evenly mixed and then molded with a cookie mold. The molded dough is baked using an oven at a treatment temperature of 110°C and 120°C for 1 hour.

## 3. Results and discussion

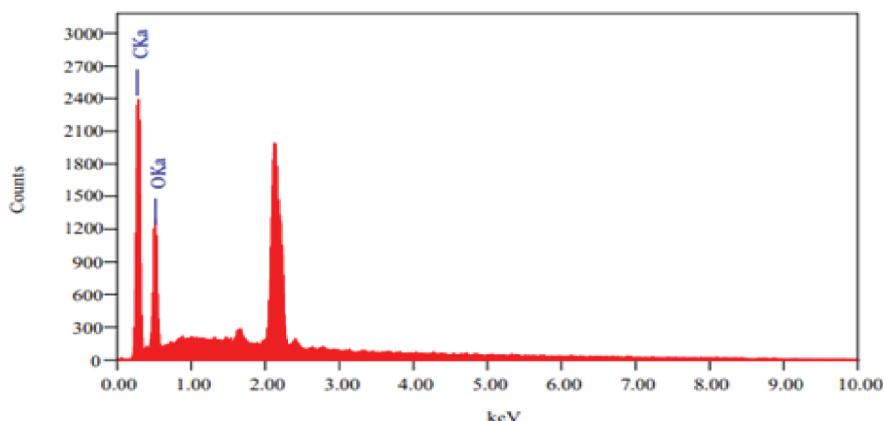
### 3.1. Scanning Electron Microscopes

The microstructure matrix of the cross-section of *mocaf* cookies with the addition of velvet beans flour and pumpkin can be understood from electron micrographs. Scanning Electron Microscope can be used to understand the internal changes in surface structure, morphology, and density that will affect the sense of the product [8]. The influence of formulation variables and temperature treatment has a real impact on the appearance of selected cookies according to the panellists. Starch granules that change shape can be seen in the results of the Scanning Electron Microscope. This tool provides an understanding of microstructure porosity, pore distribution and size [9]. The difference in structure may be caused by the presence of fiber and other components of *mocaf* flour, velvet beans flour, and pumpkin. The microstructure taken from the cross-section of *mocaf* cookies with velvet beans flour and pumpkin using SEM can be shown in Figure 1.



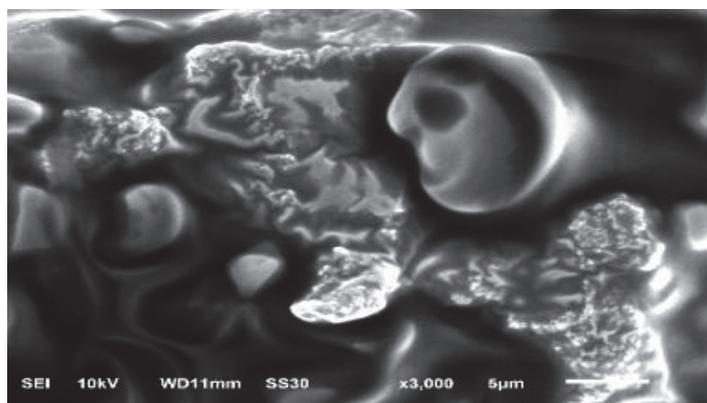
**Figure 1.** Morphology of *mocaf* cookies adding velvet beans pumpkin 30:40 at a treatment temperature of 110°C.

In Figure 1 it can be shown that the structure of the starch molecule composition appears open and separated. Increasing the ratio of *mocaf* and pumpkin provides a more open structure due to the fiber content of both materials [10]. The proportion of the composition of the distribution of Carbon and Oxygen atoms of *mocaf* cookies can be shown in Figure 2.



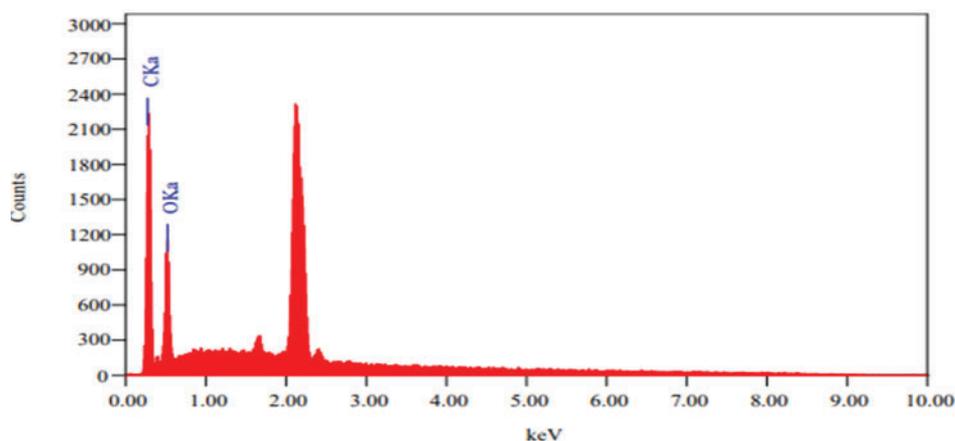
**Figure 2.** Composition of C and O atom distribution in *mocaf cookies* with the addition of velvet beans pumpkin 30:40 at a treatment temperature of 110°C.

In Figure 2. can be understood that the visualization of *mocaf cookies* with a ratio of 30:40 velvet beans flour pumpkin at a treatment temperature of 110°C contains 58% Carbon atoms and 42% Oxygen. These Carbon and Oxygen atoms come from carbohydrate molecules, which are the majority of components (70%) in *cookies*. The presence of pumpkin reduces the quality and breaking strength of *cookies*[11]. The morphology of *mocaf cookies* with the addition of 40:30 velvet beans flour pumpkin at a temperature treatment of 120°C can be explained in Figure 3.



**Figure 3.** Morphology of *mocaf cookies* with the addition of velvet beans pumpkin 40:30 at a treatment temperature of 120°C.

In Figure 3. it can be seen that the molecular structure of the surface of *mocaf cookies* is more faded and washed out. In general, starch gelatinization can occur in the range of 80°C is thought to cause starch molecules to gelatinize and break hydrogen atoms. Irregularities in the size of the structure and density will affect the sensory properties of *cookies*. The expansion of gas bubbles causes cavities in *cookies*[12]. Microscopic testing explains the differences in the structure of *mocaf cookies* at temperatures of 110°C and 120°C.

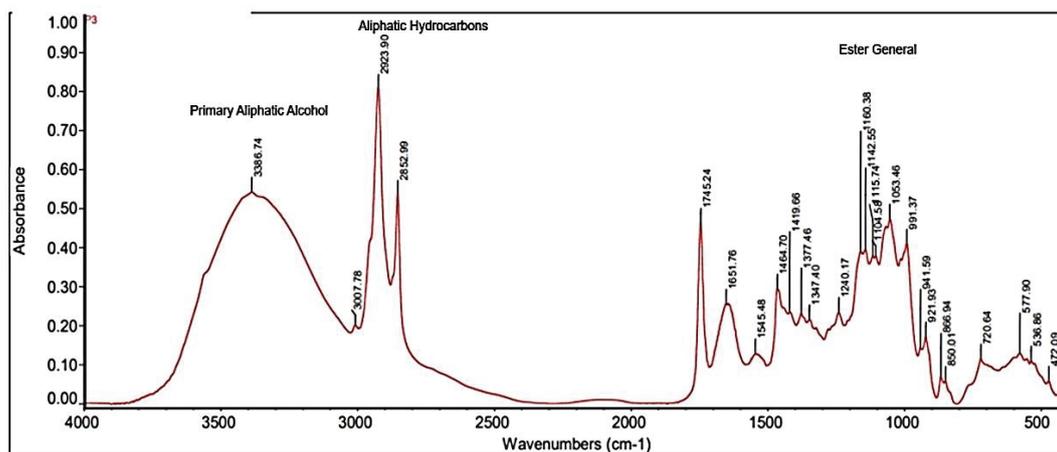


**Figure 4.** Composition of distribution of Carbon and Oxygen atoms in *mocaf* cookies with the addition of velvet beans pumpkin at 40:30 at a treatment temperature of 120°C.

Figure 4 visualizes *mocaf* cookies with the addition of 40:30 velvet beans flour pumpkin, treated at 120°C, which contain 60% carbon atoms and 40% oxygen. According to [13] the baking process is an important factor in increasing the content of resistant starch in *cookies*, this is because the degree of dough crystallization affects the formation of resistant starch. Gelatinization and retrogradation of dough with different formula compositions can also have positive and negative impacts on the content of resistant starch in cookie dough[12].

### 3.2. FTIR

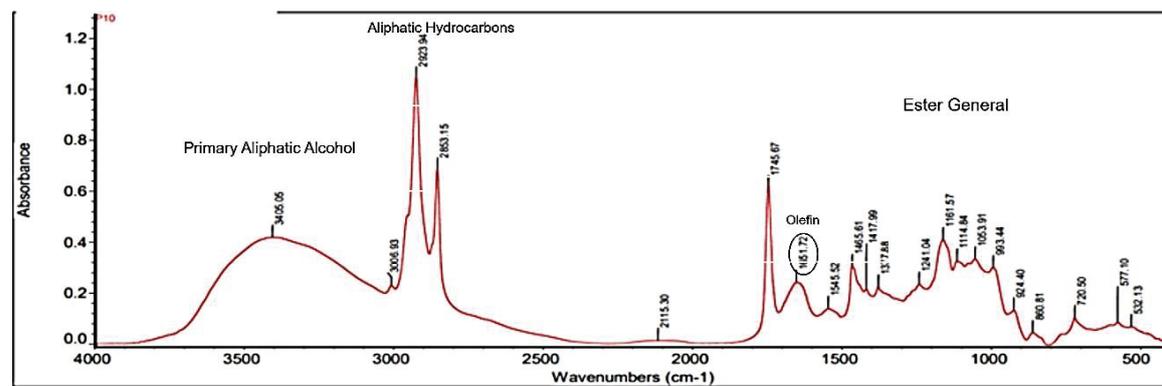
Infrared spectroscopy (FTIR) is used to validate the functional groups of a compound in the chemical analysis process. In the food industry, this method is also used as a control tool to monitor product quality. Infrared spectroscopy has been applied in the identification and validation of the authenticity of food samples[10]. The results of FTIR readings of *mocaf* cookies with the addition of 30:40 pumpkin velvet beans flour at a temperature of 110 °C can be presented in Figure 5.



**Figure 5.** Spectral reading of *mocaf* cookies with the addition of 30:40 velvet beans flour pumpkin at a treatment temperature of 110 °C.

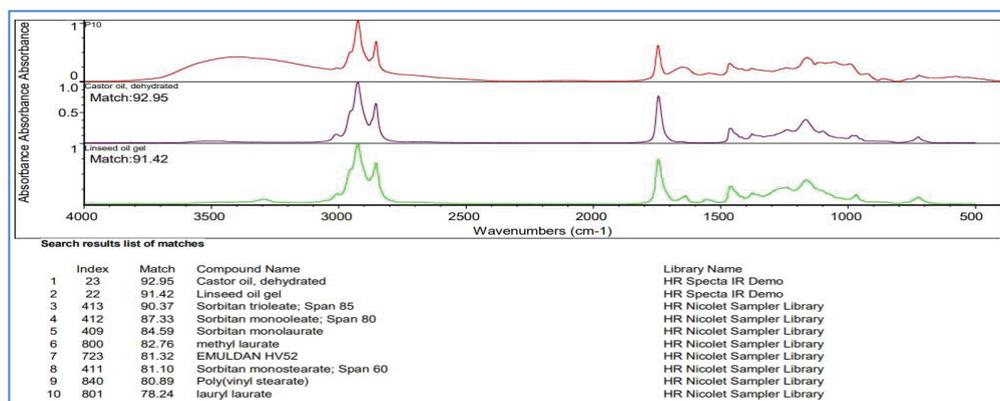
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In Figure 5, it is shown that the spectra of *mocaf cookies* with the addition of 30:40 velvet beans flour pumpkin at a temperature treatment of 110 °C contain general Ester groups, Aliphatic Hydrocarbons, and Primary Aliphatic Alcohols[14]. The results of the FTIR spectra reading of *mocaf cookies* with the addition of 40:30 velvet beans flour pumpkin at a temperature treatment of 120°C can be explained according to Figure 6.



**Figure 6.** FTIR spectra of *mocaf cookies* with the addition of velvet beans flour pumpkin 40:30 at a treatment temperature of 120°C

In Figure 6, there are olefin, ester, aliphatic hydrocarbon, and primary aliphatic alcohol groups [14]. Olefin groups, also known as alkenes, are chemical compounds containing double bonds between carbon atoms. In the context of food, olefin groups are not commonly found as natural compounds. However, some olefin compounds may be present as minor components in some food ingredients or because of certain processes, such as heating or fat oxidation [15]. The similarity to the standard compounds from Figure 5 and Figure 6 can be explained in Figure 7.



**Figure 7.** Similarity to standard.

Figure 7. shows three spectra, each representing a different sample or state. The top spectrum (red) matches "Castor oil, dry", while the middle spectrum (purple) matches "Linseed oil gel". Peak evaluation shows broad O-H or N-H stretches, C-H stretches, and C=O stretches, indicating the presence of hydroxyl or amine groups, aliphatic C-H bonds, and ester or carbonyl groups. Similarities: castor oil 93%, linseed oil 91%, sorbitan trioleate 90%, and so on[14]. At a temperature of 120 °C, *cookies* will produce peroxide compounds due to the formation of general olefin groups. Peroxide compounds are related to the quality of *cookies*. These results indicate that the temperature treatment of 120 °C can change the functional composition of food ingredients. Olefin groups, also known as alkenes, are chemical compounds containing double bonds between carbon atoms. The baking process can produce

olefin compounds from fats in food ingredients. Functional Groups: General Olefins, General Esters, Aliphatic Hydrocarbons, Primary Aliphatic Alcohols. Primary aliphatic alcohols, or primary aliphatic alcohols, are organic compounds with the structure R-CH<sub>2</sub>OH, where "R" is an alkyl chain[16]. In food, primary aliphatic alcohols are often found as natural components, especially in fruits and vegetables. Primary aliphatic alcohol in pumpkin (*Cucurbita moschata*) and velvet bean (*Mucuna pruriens*) can play a role in several aspects, such as aroma, taste, and metabolic processes.

The fingerprint region shows complex peaks due to C-O stretching and bending vibrations, which identify the compound[16]. Library matches show compounds like the tested sample, such as drycastor oil and flaxseed oil gel. Other matches include sorbitan esters and fatty acid esters, which are common in emulsifiers, indicating similar compounds or additives in the sample [14].

The analysis shows a high match score between the sample and the reference compound, indicating accurate identification. The top spectrum resembles dry castor oil, with peaks of fatty acids and possible dehydration products. The middle and bottom samples resemble flaxseed oil gel, possibly involving cross-linked or polymerized fatty acids. The figure shows three spectra, each representing a different sample or state. The top spectrum matches "Castor oil, dry," while the middle spectrum matches "Flaxseed oil gel." Peak evaluation shows hydroxyl or amine groups, aliphatic C-H bonds, and ester or carbonyl groups[14]. Library matches indicate similar compounds and high match scores indicate accurate identification. Primary aliphatic alcohols, although present in small concentrations, play an important role in determining the organoleptic characteristics and biochemical functions of pumpkin and velvet beans. Primary aliphatic alcohols play a role in flavor, biosynthesis precursors, and antioxidants. Esters in pumpkin (*Cucurbita moschata*) and velvet beans (*Mucuna pruriens*) play an important role in determining the aroma, flavor, and overall quality characteristics of these foods.

#### 4. Conclusions

The morphological structure of the *mocaf cookies*, as observed under SEM, exhibited a composition of 58% carbon (C) atoms and 42% oxygen (O) atoms. The FTIR spectroscopy analysis revealed that the addition of *Mucuna pruriens* pumpkin to the *mocaf cookies* resulted in the formation of general olefin functional groups at a temperature of 120°C.

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