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# Gel Formulation and Evaluation Of Cassava (*Manihot esculenta*) Flour As Accoustic Coupling Agent (ACA) Ultrasonography

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## ABSTRACT

**Background**: World consumption of hydrogels from synthetic polymers is more than one million tons per year[3]. This can cause serious environmental damage problems. According to[4], the amylose content of tapioca flour is in the range of 20-27%. Cassava has a high amylopectin content, with the addition of aloe vera, it is hoped that the gel will be safer and better for patients with sensitive skin problems (Jahan, 2020).
**Methods:** Experimental with true experimental design using posttest only control group design.
**Results:** Three different gel formulations were obtained, including A2 gel with a composition of 25 grams of cassava flour, 4 grams of aloe vera gel, 0.1 grams of methyl paraben and 75 mL of distilled water. Gel B2 with a composition of 25 grams of cassava flour, 4 grams of aloe vera gel, 0.1 grams of methyl paraben, 100 mL of distilled water. The composition of the C2 gel includes 25 grams of cassava flour, 4 grams of aloe vera gel, 0.1 grams of methyl paraben and 125 mL of distilled water. Gel A2 has a standard pH and spreadability.
**Conclusion:** The results of the evaluation of the formula have shown conformity with the parameters set so that gel A2 was chosen to be the optimum formula.

Keyword : Cassava, Gel, Ultrasonography.

## Introduction

Acoustic coupling agent (ACA) is the medium needed in ultrasound examination to efficiently transmit ultrasonic probes to the patient's body[1]. Lack of coupling media between the transducer and the skin can cause artifacts. One of the conventional acoustic coupling agent gel formulations is carbomer 940 (C3H4O2) which acts as a gel base which is not environmentally friendly[2]. World consumption of hydrogels from synthetic polymers is more than one million tons per year[3]. This can cause serious environmental damage problems, so efforts to reduce the use of synthetic polymer-based materials must be carried out immediately. In addition to this, conventional ultrasound ACA gel can also cause allergic reactions. To overcome this problem, synthetic polymer substitutes are needed.

One of the natural polymer producing plants is cassava. The amylose content of cassava flour is in the range of 20-27%[4]. High amylopectin content plays a role in the

manufacture of gels[1]. Seeing the high amylopectin content in cassava, this can be used as a reference for selecting cassava to replace the role of carbomer 940 as a gel base for the current ultrasound. On the other hand, cassava is able to reduce the use of synthetic polymer-based materials (non-biodegradable).

Mahendran Sekar in 2017 conducted a study entitled formulation and evaluation of natural ultrasound gel for physiotherapy treatment. Based on the study, Two different concentrations of ultrasound gel were formulated in the study containing 10% and 20% concentration of aloe vera gel. The composition for the gel formulation includes 50 grams of corn flour, 10 grams of aloe pubescens gel, 0.5 grams of methylparaben, 10 grams of salt and 500 mL of distilled water. In this study, a physico-chemical evaluation was carried out, but viscosity measurements had not yet been carried out. The results of the study demonstrated the potential benefit of sustained pain relief after ultrasound therapy with the formulated gel. Researchers recommend that the formulated ultrasound gel can be used for diagnostic ultrasound scanning[5].

Research on ultrasound gel made from cassava flour was conducted in the Democratic Republic of the Congo, the composition for the gel formulation included 8 parts of cassava flour, 1 part of salt and 32 parts of water. It has been evaluated to produce a gel that does not cause skin irritation, practicality of cost, ease of production and availability, the resulting gel is clear in contrast to corn flour based gel. However, this study did not measure the viscosity of each batch, so it is not possible to assess whether the viscosity of CFS has an effect on image quality. Preservatives have not been given so that the product only lasts 5-10 days[1].

Viscosity measurement aims to determine the level of dilution and viscosity of the gel which functions to support the gel's function as ACA which is applied to the surface of the body. Viscosity can be influenced by the amount of solvent, the more solvent means the percentage of carrageenan decreases so that the viscosity will be lower and vice versa. Therefore, in this study, to determine the gel with the best formulation, it was done by varying the solvent concentration or flour percentage.

**Methods**

This study uses an experimental research type with a true experimental design using a posttest only control group design. The study was divided into 4 groups, namely 3 intervention groups and 1 control group. The samples used in this study were conventional ultrasound gel, and cassava flour-based gel with different percentages of cassava flour (X %, Y %, Z %).

**Result and Discussion**

1. Plant Collection and Authentication

Fresh aloe vera was purchased at Bu Mamik's Aloe Vera Garden, Batu City and identified by LIPI- Purwodadi Botanical Gardens, Pasuruan. Once identified, the collected leaves (Fig. 1) were washed thoroughly with distilled water to remove yellow liquid secretions and residue, if any.

Figure 1. Aloe Vera Plant.

2. Manufacture and Determination of Gel Formulation

The gel formulation was adopted from Mahendran Sekar's (2017) gel formulation, by substituting corn flour into cassava flour, and eliminating the use of salt, this is in accordance with the United States Food and Drug

Administration (FDA) standard number K101952 that ultrasonographic gel products must not contain salt. Preliminary gel preparation was carried out to obtain a formula that was most suitable for the physical properties of the manufacturer's gel, based on the results of the preliminary test, the most suitable formulation with the manufacturer's gel was the C1 gel formulation, which included 25 grams of cassava flour, 4 grams of aloe vera gel, 0.1 methyl paraben. grams and 100 mL distilled water.

In this study, no extraction process was carried out. The fresh part of the aloe vera gel is directly added to the formulation. First, the fresh gel part of the plant is separated from the leaves and ground using a mixer until liquid. After that, the gel was filtered to remove any remaining particles in the liquid. To avoid contamination, freshly prepared Aloe Vera gel juice is covered with aluminum foil and stored in the refrigerator throughout the period. Mixing 50 g corn flour, 10 g aloe vera gel, 0.5 g methylparaben, 10 g salt, and 500 mL ditilled water can be used as a topical gel base [5].

Preliminary experiments were carried out to make gels per 100 grams of ditilled water to determine the appropriate concentration of carrageenan in making a gel whose characteristics resembled ACA gel (carbomer 940). Then made variations in the concentration of cassava flour 10 grams, 15 grams, 25 grams for every 100 grams of ditilled water solution.

The manufacture of cassava flour gel with the addition of aloe vera begins with distilled water put into a beaker and heated to boiling, then, cassava flour is put into boiling water with a consistent stirring rate with the help of a magnetic stirrer, to avoid clumping, boiled until it becomes a thick gel. After boiling, methylparaben and salt were sprinkled into the solution followed by aloe vera gel with continuous stirring to form a homogeneous gel. The gel is allowed to stir continuously for about 1 hour and set aside to cool. In the last step, the gel was transferred into a different bottle and stored at the right temperature until further use [5].

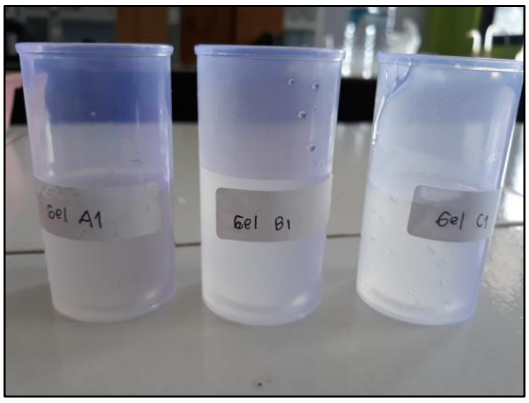


Figure 2. Cassava flour based gel introduction

Table 1. Preliminary gel formulation

| Material | Gel A1 | Gel B1 | Gel C1 |
|---|---|---|---|
| Cassava flour | 10 g | 15 g | 25 g |
| Aloe vera gel | 4 g | 4 g | 4 g |
| Metil paraben | 0,1 g | 0,1 g | 0,1 g |
| Distilled water | 100 mL | 100 mL | 100 mL |

Table 2. Preliminary gel organoleptic test results

| Gel | Organoleptic | | |
|---|---|---|---|
| | Colour | Scent | Concistency |
| A1 | White | Cassava | Very liquid |
| B1 | White | Cassava | Liquid |
| C1 | White | Cassava | Thick |
| D | Blue-clear | Chemical material | Very thick |

After evaluation by organoleptic test, the formulation that most closely resembled the manufacturer's ACA gel was formulation C, 25 grams for every

100 grams of distilled water solution. Then make variations of distilled water 75 grams, 100 grams and 125 grams to get different variations of gel viscosity. Viscosity can be influenced by the amount of solvent, the more solvent means the percentage of flour decreases so the viscosity will be lower.

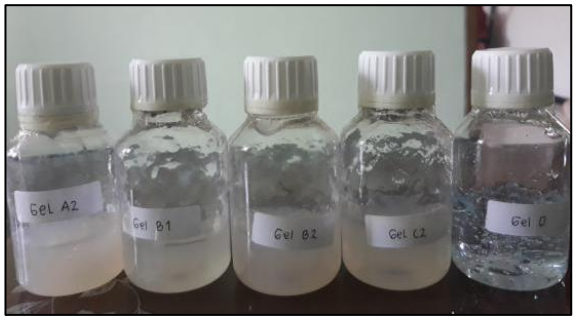


Figure 3. Cassava flour based gel and manufacturer's gel

Table 3. Gel Formulation

| Material | Gel A2 | Gel B2 | Gel C2 |
|---|---|---|---|
| Cassava flour | 25 g | 25 g | 25 g |
| Aloe vera gel | 4 g | 4 g | 4 g |
| Metil paraben | 0,1 g | 0,1 g | 0,1 g |
| Distilled water | 75 mL | 100 mL | 125 mL |

3. Test Physical Properties of Gel

The requirements for acoustic coupling agent products on ultrasound examination according to the United States Food and Drug Administration (FDA) number K101952 have main characteristics, namely: not causing allergies so they do not cause skin, soluble in air, do not use dyes, easy to clean, do not contain vegetable oil and oil, does not contain formalin and salt, non-toxic, odorless, harmless to transducers, no air bubbles, and pH 7. Therefore, in this study, organoleptic tests were carried out.

Table 4. Test results of the physical properties of the gel

| Parame-ter | Gel code | | | |
|---|---|---|---|---|
| | A2 | B2 | C2 | D |
| Organoleptic | | | | |
| Colour | White | White | White | Blue-clear |
| Scent | Cassa-va | Cassa-va | Cassa-va | Chemi-cal |
| Concis-tency | Very thick | Thick | Thick | Very thick |
| Removal | Easy | Easy | Easy | Easy |
| Viscosity/ centipoise | 41.50 | 5.950 | 8.450 | 366.0 |
| pH | 5,07 | 4,89 | 5,10 | 6,50 |
| Spread-ability (cm) | 5 | 3,4 | 3,8 | 7 |
| Homoge-nity | Homo gen | Homo gen | Homog en | Homo gen |

The composition of the gel is said to be homogeneous if there is an even color equation and no different particles are found[7]. Consistency, acidity and spreadability of the gel are related to the comfort of use. Gel preparations are expected to have consistency, acidity and spreadability according to the criteria parameters. The soft gel consistency causes the gel to be more evenly distributed, easily absorbed into the skin and feels soft on the skin than stiff gels. The consistency of the gel is related to its viscosity and spreadability. A good gel pH is a pH that is almost the same or close to the skin's pH, which ranges from 4.5 to 6.5. If the gel preparation is too acidic from the pH of the skin, it is feared that it will irritate the skin, but if it is too alkaline, the skin is feared to be dry[8]. The results of the dispersion of gel preparations are included in the SNI standard, which is between 5.54-6.08 cm. Good spreadability of the gel between 5-7cm. The greater the dispersion given, the wider the ability of the active substance to spread and contact with the skin.

Based on table 4 the results of the physical properties test of the gel, it can be seen that all tapioca flour-based gels with various solvent concentrations have a white color, have a characteristic smell of cassava, are easy to remove (removal) and are homogeneous. The consistency of A2 gel is the same as that of the manufacturer's gel, has the highest viscosity value compared to B2 and C2 gels, has a pH of 5.07, has the widest spreadability compared to B2 and C2 gels, which is 5 cm.

**Conclusion**

1. Three different gel formulations were obtained, including A2 gel with a composition of 25 grams of cassava flour, 4 grams of aloe vera gel, 0.1 grams of methyl paraben and 75mL of distilled water. Gel B2 with a composition of 25 grams of cassava flour, 4 grams of aloe vera gel, 0.1 grams of methyl paraben, 100 mL of distilled water. The composition of the C2 gel includes 25 grams of cassava flour, 4 grams of aloe vera gel, 0.1 grams of methyl paraben and 125 mL of distilled water.
2. Gel A2 has a pH and dispersion power according to standards, the results of the evaluation of the formula have shown conformity with the provisions of the parameters so that gel A2 was chosen to be the optimum formula.

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