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Saluyot (*Corchorus olitorius L.*) Leaves as Acoustic Gel for Ultrasound Imaging

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ABSTRACT

Ultrasound is aided with acoustic gel to provide an accurate medical diagnosis; however, this product is costly and, thus, may hinder the diagnostic value of the procedure. This research is focused on the evaluation of radiographic image quality parameters of sonograms scanned using Saluyot leaves and commercial acoustic gels. Twelve participants were purposively chosen and subjected to an Ultrasound scan using the acoustic gels. Recorded sonograms were evaluated using the standard radiographic image quality parameters. Results revealed that sonograms obtained using Saluyot leaves were more acceptable, more visible, more detailed, and less distorted compared to commercial acoustic gel. Statistical analysis showed that there is no significant difference in the level of acceptability and distortion of the sonograms obtained using the Saluyot leaves and commercial acoustic gels. However, there is a significant difference in the visibility and amount of recorded detail of the sonograms using the two gels.

Keywords: Health, Saluyot leaves, Acoustic gel

INTRODUCTION

For ultrasound to be effective, a conducting medium must be placed between the probe and the skin. Rumack (2011) and Tempkin (2014) stated that there would be no potent transmission of ultrasound waves if only an air gap exists between the probe and the skin. Odwin and Fleischer (2012) further elaborated that the absence or ineffectiveness of a conducting medium would cause a reflection of more than 99.998% transmitted ultrasound waves from the skin back to the probe. An acoustic gel is formulated to solve this problem. Heinar (2013) defined an acoustic gel as a colorless viscous liquid that contains thickening agents to transfer sound waves and improve its spreadability on the skin. Morley, Donald, and Sanders (2013) characterized the function of an acoustic gel as a substance that excludes air from the region between the probe's head and the patient's skin, allowing the ultrasound wave to pass into the tissue at its highest intensity.

However, despite solving the dilemma, the new product entails an additional financial burden to the public. Several scholarly works of literature have been circulated, pointing out that the burden is accentuated in low-resource settings and medical schools that are implementing ultrasound education. Partners in Health, one of the largest global health care organizations, has studied the application of ultrasound in low-resource settings. They found it to be a teachable skill that is helpful in patient care and a critical component in global health delivery but identified lack of availability and costs of gel as limitations to its use (Shah et al., 2008). Furthermore, the study revealed that some clinics located in low-resource areas have ultrasound machines but are unable to perform the studies due to the ongoing costs of the gel. Another study of Shah et al. (2015) found out that 32.6% of the 138 respondents representing 44 low- and middle-income countries from the continents of Africa, South America, and Asia, identified the lack of gel as one of the obstacles to ultrasound use. Henwood et al. (2014) also found out that 57% of Emergency Medicine (EM) residents in Colombia recognized the absence of ultrasound materials as a stumbling block to point-of-care ultrasound.

Given these hindrances, there is a need for an alternative. A handful of previous studies have been published examining alternatives to the commercially available acoustic gel. Blaivas et al. (2004) published a case series of seven cases using a water bath as an ultrasound medium. This, however, is only applicable to extremities, and no validation of image quality has been done. Luewan et al. (2007) published a study of 346 cases (692 scans) comparing ultrasound gel to olive oil and found no significant difference in image quality. Both water and oil are potential alternatives to the commercially available gel; however, both have significant drawbacks. It is difficult to create enough contact with the skin using water to obtain adequate images. Oil is messy, can stain clothes, and, again, does not provide enough surface contact to obtain high-quality images. Riguzzi et al. (2016) compared cornstarch-based gel with commercially available gel and found no significant difference in image quality; however, considerations of sterility and contamination of gel to participants was overlooked. In general, there appears to be a scarcity of research on ultrasound gel alternatives.

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For this reason, the researchers tested the feasibility of saluyot (Corchorus olitorius L.) leaves as an acoustic gel for ultrasound imaging.

Saluyot (*Corchorus olitorius* L.) leaf is an edible leafy vegetable that can almost grow anywhere in the Philippines (Nelz, 2016). Potter (2010) described it as a clear thickener in soups. In fact, after extraction of saluyot (Corchorus olitorius L.) leaves by Montaño et al. (1997), they found out that the relative viscosity of a 1.0% solution of the mucilage was determined to be 20 millipascal-seconds at room temperature, and the molecular weights were approximated to be 1700 g/mol for the saluyot mucilage. Various studies have been conducted confirming the antibacterial and antimicrobial properties of the leaves, as well as its shelf life. Ilhan et al. (2007) found out that the leaves presented a good antimicrobial activity against *Escherichia coli*, *Staphylococcus aureus*, *Yersinia enterocolitica*, *Geotrichum candidu*, and *Botrytis cinerea* while Zakaria (2006) concluded that the extract of the leaves possesses antibacterial activity that is comparable to some of the standard antibiotics. According to Tulio et al. (2002), the leaves had a longer storage life at 8°C than with the other storage temperatures, and the shelf life was found out to be eight days. However, Abu-Khalaf et al. (2017) showed that at 4°C, the shelf life was two weeks.

Considering these points about saluyot (*Corchorus olitorius* L.) leaves, the researchers identified it as a potential gel alternative that would address the scarcity and cost of commercial acoustic gel and would, therefore, benefit the low-resource community, medical schools that are implementing ultrasound education such as Davao Doctors College and radiology department in the hospital. Moreover, the researchers would like to hypothesize that images obtained using a saluyot (*Corchorus olitorius* L.) gel was not inferior to commercial acoustic gel based on the radiographic image critique, using an experimental crossover design.

METHODOLOGY

Design

In this study, an experimental crossover design was used. In the study, the participants were both subjected to commercial gel and saluyot gel. It is in this light that the method was used because the focal point of this research is to test if the saluyot gel is feasible as an alternative to commercial acoustic gel for ultrasound imaging. Also, this design was used to control the individual differences among participants, as each participant acts as their own control.

Setting

The experiment was conducted at Davao Doctors College, General Malvar Street, Davao City. The researchers conducted the study in this area because of the availability of the materials and machine that were used in the experiment. Specifically, the preparation of saluyot gel was conducted at the 5th Floor General Laboratory, and the scanning of patients was conducted at the 1st Floor Radiologic Technology Laboratory, where the ultrasound machine is located.

Research Procedure

A letter of permission to conduct the study was given to the Program Chair of the Radiologic Technology Program of Davao Doctors College. Afterward, the researchers proceeded with the actual experimentation of the saluyot (*Corchorus olitorius* L.) leaves.

The saluyot (*Corchorus olitorius* L.) shoots weighing 500 grams were taken from an authorized plant shop at Bankerohan Public Market, Building Number 2, Marfori Street, Barangay 5-A, Davao City, Philippines. These shoots were specified and verified by Dr. Reynaldo G. Abad, a Botanist. The procedure in making an acoustic gel followed the steps of Riguzzi (2016), who found out that a 1:1 water-to-added substance ratio would yield the best consistency of the gel. The following laboratory equipment and materials were used in the study: 500-ml beaker, stirring rods, electric stove, thermometer, strainer, and standard ultrasound gel bottles. The saluyot gel was made before 6 hours of its use in the study. The saluyot leaves were removed from their stems, washed under flowing water and then were set aside. The leaves were weighed, and 300 grams of samples were obtained. The researchers put 300 ml of purified water and 300 grams of leaves inside the 500-ml beaker. These were then heated using the electric stove for 15 minutes under a temperature of 80°C to 90°C. The mixture was removed from the 500-ml beaker, strained using a fine mesh strainer to ensure removal of saluyot leaves and was set aside for 30 minutes. The produced saluyot gel was placed directly into empty, sterilized, standard acoustic gel bottles. The saluyot leaves were disposed to a container for organic waste.

Twelve participants were purposively chosen using the following criteria: female, age range of 30 to 40 years old, weight in the range of 50 to 60 kilograms, no history of pathology in the thyroid gland, physically fit in the recent physical examination, 17 cm anteroposterior diameter and 13 cm transverse diameter of neck, and valid to carry out a written informed consent. Before testing the saluyot gel to the participants of the study, they first underwent patch testing by Lachapelle and Maibach (2012) for 48 hours to determine if they will have any negative side-effects after the application of saluyot gel on the skin. The test allowed relative and rapid assessment of the participant's skin tolerance regarding the application of saluyot gel during the examination proper of the study. The saluyot gel was dabbed on the participant's non-dominant hand using cotton. Cotton with saluyot gel smaller in size was placed on the area with gel and was covered with transpore. The patients were given with saluyot gel and were instructed that every 8 hours, the patch should be changed, and saluyot gel will again be applied to the same area. The participants' patches were checked after every 8 hours. After a total of 48 hours of observation, participants were referred to Mr. Garizaldy A. Masayon, a Registered Nurse.

Subsequently, participants who exhibited false-negative results in any reaction to saluyot gel were considered for the sonographic examination of the thyroid gland. The results showed that all participants exhibited

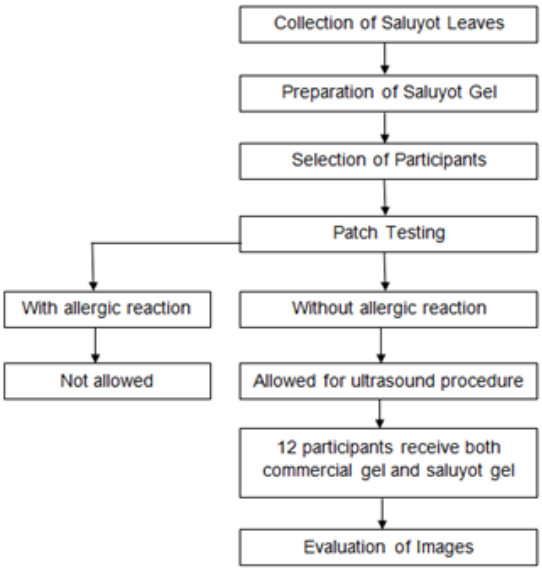

Figure 1. Schematic Diagram of the Procedures of the Study

no allergic reaction to the saluyot gel. The participants underwent a sonographic examination of the same organ, thyroid gland, using the probe with the same scanning time. The linear probe was used, and the scanning time was 1 minute. GE Healthcare Ultrasound Machine was used during the study. There were two sets of sonographic examinations. For the first set, the 12 participants were randomly assigned to either commercial gel or saluyot gel, and for the second set, the same participants were assigned to the other gel. These two sets allowed all participants to be subjected to both the commercial gel and saluyot gel in a random manner. The scanning of participants happened on the same day and in the same room. The researchers followed the sonographic scanning protocols and techniques of Ovel (2014).

For the first set, the participants were asked to remove all accessories in the neck area. They were placed in a supine position with a pillow or cushion placed under the shoulders so that the head and neck were moderately extended. Ten mL of either commercial gel or saluyot gel was placed on the thyroid gland by the ultrasonographer. The same amount of gel was placed throughout the study. The probe was then placed over the outer surface of the thyroid gland, and an image was then captured and saved. After undergoing the first set of sonographic examination in the 12 participants, the gel was removed from the participants, and the probe was cleaned with a cloth soaked in alcohol and then wiped with a dry cloth. For the second set of sonographic examination, the same participants were positioned on the same bed. The other gel was placed on the same surface of the thyroid gland by the same ultrasonographer, and the same amount of gel was placed. The same probe was then placed over the outer surface of the thyroid gland, and an image was then captured and saved.

All of the images were saved with the same size of information, which is 80 kilobytes. All of the settings in the ultrasound machine were the same for each examination. After images were saved, these were sorted according to the type of acoustic gel for evaluation. The images were evaluated by one experienced ultrasonographer, who has more than ten years of experience in the profession. To avoid observational bias, the ultrasonographer was not informed of the type of acoustic gel during evaluation. The same laptop, the brightness of the screen, and room lighting were used during the evaluation of each image. The images were also evaluated on the same day. Figure 1 shows the schematic diagram of the procedures of the study.

Statistical Treatment

Descriptive and inferential statistics were used in the analysis of data. Mean was utilized to compute the average score of the radiographic image quality parameters obtained using Saluyot leaves and commercial acoustic gels. After satisfying the assumptions for running a parametric inferential test, a t-test for independent samples was used to compare the image quality parameters of sonograms using Saluyot leaves and commercial acoustic gels.

RESULTS AND DISCUSSION

Research findings here are presented in two sections: descriptive and t-test for independent samples. Table 1 presents the radiographic image quality parameters and corresponding means of sonograms obtained using Saluyot leaves and commercial acoustic gels. Table 2 presents the test of significant difference between Saluyot leaves and commercial acoustic gels.

Table 1 shows the radiographic image quality parameters of sonograms obtained using Saluyot leaves and commercial acoustic gels. In terms of the level of acceptability, visibility of detail, amount of recorded detail, and distortion, the sonograms produced using Saluyot leaves gel obtained a mean score of 4.58, 4.42, 4.25, and 1.08, respectively. On the other hand, the sonograms obtained using the commercial acoustic gel obtained a mean score of 4.25, 3.42, 3.33, and 1.25 in terms of acceptability level, visibility of detail, amount of recorded detail, and distortion.

The sonograms produced using Saluyot leaves gel were more acceptable, more visible, more detailed, and

Table 1

Radiographic Image Quality Parameters of Sonograms Obtained using Saluyot Leaves and Commercial Acoustic Gels

Parameters	Saluyot	Commercial
Level of acceptability	4.58	4.25
Visibility of detail	4.42	3.42
Amount of recorded detail	4.25	3.33
Distortion	1.08	1.25

Table 2

Test of Significant Difference Between the Saluyot Leaves and Commercial Acoustic Gels

Parameters	*p*-value
Level of acceptability	0.11
Visibility of detail	0.00*
Amount of recorded detail	0.00*
Distortion	0.29

Note. *p<0.01

less distorted compared to the commercial acoustic gel. This implies that the quality of Ultrasound images obtained using Saluyot leaves gel as measured by the four standard parameters is higher compared to the images produced using the commercial acoustic gel.

Table 2 illustrates that there appears to be no significant difference in the level of acceptability and distortion of the images obtained using the Saluyot leaves and commercial acoustic gels. However, there is a significant difference in the visibility of detail and amount of recorded detail of the images obtained using the two acoustic gels. This means that the Saluyot leaves gel was found to be superior to commercial gel with respect to visibility of detail (4.42 vs. 3.42) and recorded detail (4.25 vs. 3.33). This suggests that ultrasonographers who want to visualize the detail on the image clearly, identify the structural lines or borders of tissues in the image and decrease the unavoidable amount of blur of the image may use the Saluyot leaves gel (Bushong, 2013). With adequate detail, even the smallest parts of the anatomy are visible, and the radiologist can more readily detect tissue abnormalities (Bushong, 2013). This finding concurs to the study of Riguzzi et al. (2016), which reported a significant difference in the mean image detail score, mean resolution score, and mean image quality score between images obtained using commercial gel and cornstarch gel as the alternative.

CONCLUSIONS

The quality of images obtained from the Ultrasound scan using Saluyot leaves gel is superior compared to that of commercial acoustic gel. Both gels produced images that have statistically the same level of acceptability and distortion. However, the images obtained using Saluyot leaves gel exhibited statistically higher visibility of detail and amount of recorded detail compared to those of commercial acoustic gel. Therefore, the Saluyot leaves gel may be used as an alternative acoustic gel for Ultrasound imaging. Furthermore, it could possibly be a preferred media because of its lower cost and ease of formulation.

RECOMMENDATIONS

Future researchers may test the Saluyot leaves gel for other parameters such as viscosity to optimize its application to the skin surface and shelf life. Concurrently, considerations of sterility and contamination should be further investigated. Additionally, future studies should increase sample size and enroll actual patients as participants, with a proportion having abnormal ultrasound findings. It is also suggested that the formulation of Saluyot leaves gel may be implemented in low-resource setting and medical schools that are teaching ultrasound education to help determine its feasibility in day-to-day practice.

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