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Production of Dental Separating Medium using Tapioca extracted from *Manihot esculenta* in Enugu, Nigeria

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Abstract

Tapioca is a starch extracted from the root of the cassava plant (*Manihot exculenta*). Cooks and bakers rely on it for baking and for soup thickener but in dentistry the appropriate mixture in weight and volume of starch, water, glycerin and ethyl alcohol forms separating medium. A separating medium prevents direct contact between the denture based resin and the model surface. This study aimed at production of dental separating medium using tapioca extracted from *Manihot exculenta* in Enugu, Nigeria. The research was carried out between August and September, 2018 in Enugu, Nigeria. The study adopted a three phased experimental approach using the same procedures but different weight and volume compositions. Structured, pretested Product Evaluation Data Sheet was used to evaluate the product by selected Practicing Dental Technologists in Enugu State, Nigeria. The resultant separating medium from experiment III with the following composition: starch flour 1200g, glycerin 500ml, ethyl alcohol 500ml, colorant 500ml and 4000ml of distilled (hot and cold) water. There was significant agreement among the respondents in the flow ability of the product 8(40%); excellent product effectiveness 8 (40%); smoothness 8 (40%), and color stability of the product 10 (50%). These findings suggests that dental separating medium can be produced locally in Enugu, Nigeria. Therefore, more attention needs to be paid in the production process, which will facilitate easy practice of Dental Technology, and also conserve huge foreign exchange being spent in the importation of separating medium in Nigeria.

Keywords: Dental, Cassava, *Manihot exculanta*, Separating Medium, starch, Tapioca.

INTRODUCTION

Cassava (*Manihot esculenta*) is one of the most cultivated and consumed food crops in many parts of the world. It is a woody perennial and branched shrub that can grow up to 5 metres in height. It has variety of species with large, spirally arranged, lobed leaves of variable forms. During growth, the shrubs produces tuberous roots as reserves made of up to 35% starch. These tuberous roots, which may reach up to 1metre in length and together may weigh up to 40kg. Cassava produces small, regular female and male flowers in small clusters. The shrub produces a form of non-fleshy fruit capsule [1]. In continents like Africa, *manihot esculenta* plays a critical role, because many populations such as Nigeria depend on it as source of daily diet, and for economic reasons [2].

Manihot esculenta may be processed in different forms and series of by-products are formed. The processing is based on two semi-finished products: cassava paste (fermented or unfermented), and cassava chips of which starch remains one of its by-products. The wet starch is heated in a pan, stirring continuously until the grains burst and gelatinise into globules. In West Africa, most of the increases in *manihot esculenta* production were achieved in Ghana and Nigeria. One of the advantages *manihot esculenta* has over other starchy crops is the variety of uses to which the roots can be put. Apart from being a staple food for humans (especially in Africa), it additionally has an excellent potential as livestock feed, and in textile, plywood, paper, brewing, chemical and pharmaceutical industries [2, 3, 4].

Culturally, important food crops like *manihot esculenta* tend to have powerful symbols in cultures, but mostly in South America. For example, the native tribe of Tukanoan, see yucca (product of *manihot esculenta*) as their most important and highly valued food, and they consumed it in meals and snacks. Natives from Tukanoan believe that *manihot esculenta* was the first food that was planted.

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They believe it was planted by the first woman to make bread to the first man. For them, the extracted starch is the purest and one of the nourishing food they can get [5]. In the treatment of diarrhoea, scabies, and dysentery, the roots of bitter varieties can be used. Also, for treating constipation and indigestion, drinking the juice of the tubers would be helpful. The flour made out of the roots can be used as a powder for the skin once it's mixed with carapa oil and rum, and this would be very effective as a treatment for abscesses, skin eruptions, and fungal dermatitis [6]. A treatment for people suffering from glaucoma, is to take the foam-like material in the center of the stem and rubbing it across the patient's eye [6].

Starch from *manihot esculenta is* further considered to be a good natural adhesive. There are two types, which are modified starches and dextrins, which can be presented as roll-dried adhesives and liquid adhesives. It seems that for the adhesive industry, cassava is designed to be the most important factor of it. While manufacturing the glue, the starch is coagulated in hot water or with the help of chemicals. Though, for conversion into dextrin, the process is subjected separately or simultaneously into the disintegrative action of chemicals between heat and enzymes. The three main types of dextrins are: british gums, white dextrins, and yellow dextrins. Industries also have applied the use of dextrins in nonfood products [3].

In Dental technology practice, during prosthodontic steps of processing of acrylic denture base and like materials, a separating medium must be used to prevent direct contact between the denture base material and mold surface [7, 8, 9]. Separating media are materials applied on the surface of other materials such as plaster, metal, or wax to fill the pores and effect coating thereby preventing the adherence between that surface and other materials [8, 10, 11, 12]. In properties, separating medium should have qualities of applying in extremely thin layer as well as not modify the surface to which it was applied [5, 13, 14, 15]. Also, when separating medium dry it should present a smooth, glazed surface so as to impart a corresponding smooth surface to the tissue surface of the denture base [7, 8], finally it should adhere and dry quickly to the surface which it was applied [14].

There are however, large number of materials used as a separating medium in dentistry, Tin foil was the first material; it is most effective as a separating medium [14, 16]. These materials usually do not do not undergo chemical reaction with the surface of the materials on which they are applied but simply dries to form a shiny surface [7, 17]. Detery isolate and cold mould seal are other materials used as separating material; they are suitable for both packing, pressing technique and cast moulding, making tough elastic film which is unbreakable under pressure [17, 18, 19].

Starch has been used to produce a separating medium, and it is envisaged that it can be used as primary constituent of dental separating material which prevents water passing from the mould surfaces into the denture base resin, and also prevents free monomer soaking from denture base resin into the mould portion; otherwise this will lead to a compromise in the physical properties, strength, porosity and surface roughness of the processed denture base material [17, 18, 19]. Starch separating medium is a colloidal dispersion or hydrosols; a hydrosol is a colloidal substance that has its dispersed phase as a solid and the dispersion medium as a liquid. It has its dispersed phase as starch, which is prepared in a hot distilled water. When they are mixed, a sol if formed, which is translucent [20].

In the production of dental separating medium using starch, distilled water, glycerin, ethyl alcohol and colouring agent plays a very great role. ***Starch*** as the main constituent of starch separating medium can be found in dispersed phase in form of viscous liquid and it is responsible for the electrostatic stabilization of starch separating medium. Electrostatic stabilization is based on mutual repulsion of electrical charges. It increases the shelf life by adding additional mass to the medium [21]. Glycerin is a chemical compound with the formula $C_3H_8O_3$. It is a material of outstanding utility with many areas of application. The key to glycerin's technical versatility is a unique combination of physical and chemical properties, ready compatibility with many other substances, and easy handling [22]. Glycerin is also virtually nontoxic to human health and to the environment. Physically, glycerin is a water-soluble, clear, almost colorless, odorless, viscous, hygroscopic liquid with a high boiling point. Chemically, glycerin is a trihydroxyl alcohol, capable of being reacted as an alcohol yet stable under most conditions. With such an uncommon blend of properties, glycerin finds application among a broad diversity of end uses. To some users, glycerin is the material of choice because of its physical characteristics, while other uses rely on glycerin's chemical properties [22]. It also serves as a preservative in starch separating medium, which helps to preserve the medium for very long time upon storage. Harrison (2004) [23] explained that glycerin can also be called glycerol, it is a sugar alcohol and fittingly is sweet tasting and of low toxicity [23]. Glycerol has three hydrophilic alcoholic hydroxyl groups and its hydroscopic nature. Its surface tension is 64.001m at 20^0c and it has a temp coefficient of 0.698 [24]. It is a viscous liquid with sweet taste when pure, it melts at 18.6^0C (66^0F), boils with some decomposition at 290^0C (554^0F) and oils in the production of soap.

Distilled Water (cold and hot) is the continuous phase in starch separating medium, it dissolves the starch evenly to form a hydrosol [25]. ***Ethyl alcohol*** is the common name for the hydroxyl derivative of the hydrocarbon ethane [26]. This relationship is clearly demonstrated by the structural formulas for the two compounds. It is useful as a solvent for many substances and in making perfumes, paints, lacquers, adhesives, dyes, oils, waxes, cosmetics and explosives. It allows uniform mixing of starch with other constituents giving it a homogenous mixture throughout [27]. ***Coloring agents*** are chemicals and substances that impact color including soluble dyes and insoluble pigments. They are used in inks, paints and as indicator and reagents. Some of the substances that carry out these functions are malachite green, brilliant cresylic blue, methyl green, and fuchsia pink etc [28].

Considering the impacts of various dental separating medium importation and especially cold mould seal on the economy of Nigeria as a nation, Production of Dental separating medium using tapioca extracted from *Manihot exculenta* in Enugu, Nigeria became paramount.

MATERIALS AND METHODS

Study area

The study was conducted at the Federal College of Dental Technology and Therapy, Enugu, Nigeria. The raw materials were sourced from the state. Enugu state is one of the 36 states in Nigeria. Located in the southeastern part of the country, Enugu spreads its borders to the states of Kogi and Benue to the north, Ebonyi to the east, Abia and Imo to the south and Anambra to the west, covering an area of around 8,730 km^2.

Its landscape changes from tropical dense rain forest in the south to small round-topped hills covered by open grasslands with occasional clusters of woodland in the middle to sometimes almost sandy savannah in the north. The state includes most of the Udi-Nsukka plateau, a pair of plateaus that form a nearly continuous elevated area. The Nsukka plateau extends about 130 km from Nsukka in the north, to Enugu in the south and continues southward for about 160 km to Okigwe. It rises more than 300 metres and its highest part is found 20 km northwest of Enugu. The steep slopes form spectacular views of the hills and lowlands, broken up by numerous streams and rivulets feeding the Niger and Benue rivers.

Farming and trading constitute the key occupations in the state's economy: yam, cassava and palm-oil produce are the main crops, but corn, rice, pumpkin, melon, beans, okra, avocado, pineapple and even cashew nuts are cultivated as well. Besides coal, new mineral deposits have recently been discovered in Enugu State. These include limestone, iron ore, crude oil, natural gas and bauxite.

Study Design

This study is an experimental study design that focuses on the production of dental separating medium using tapioca extracted from *Manihot esculanta* in Enugu, Nigeria.

Raw Materials for the production

Cassava starch, coloring agent (fuchsia pink) flakes and (five) 5litres plastic container used were purchased from the popular Abakpa Market in Abakpa, Enugu East, Enugu state, Nigeria. The distilled water, glycerin and ethyl alcohol were all obtained from the Chemistry laboratory of the Faculty of Applied Science of the Federal College of Dental Technology and Therapy, Enugu, Nigeria.

Instrument for the production

Soft brush, Weighing balance, Beaker, Pipette, Graduated glasses, face mask, hand gloves, measuring cylinder/jug, plastic paddles for mixing, and plastic mixing bowl were obtained from the Chemistry Laboratory of Federal College of Dental Technology and Therapy, Enugu, Nigeria.

Figure 1: Laboratory preparation process

Preparation of starch samples

3000ml of distilled water was poured into a measuring beaker, followed by 500ml of glycerin. The glycerin immediately settled on the bottom of the measuring beaker because of its viscous nature. Then 500ml of ethyl alcohol was equally poured into the measuring beaker. The solution was then stirred with a mixing paddle to obtain a homogeneous solution. The solution was then covered and left for 24 hours for proper settling since glycerin is heavier than water. At the expiration of the 24 hours; 500ml of the fuchsia pink colourant and 1000ml of hot distilled water was added to the already prepared solution and stirred equally. 1200 grams of starch flour was poured in a plastic mixing bowl and the already prepared solution [distilled water (cold and hot), glycerin, ethyl alcohol and fuchsia pink colourant] was gently poured into the bowl containing the starch and stirred vigorously with the rubber paddler until the mixture became sol and viscous.

Production Process

Experiment I: The raw materials used in this experiment were measured to the following specifications: 400g of starch flour, 1000ml of glycerin, 500ml of colorant, and 5000ml of distilled water. These measured materials were mixed in a plastic bowl and stirred vigorously until a sol is observed. The processes was observed closely and recorded.

Experiment II: The raw materials used in this experiment were measured to the following specifications: 800g of starch flour, 1000ml of glycerin, 1000ml of ethyl alcohol, 500ml of colorant, and 4000ml of distilled (hot and cold) water. These measured materials were mixed in a plastic bowl and stirred vigorously until a sol is observed. The processes was observed closely and recorded.

Experiment III: The raw materials used in this experiment were measured to the following specifications: 1200g of starch flour, 500ml of glycerin, 500ml of ethyl alcohol, 500ml of colorant, and 4000ml of distilled (hot and cold) water. These measured materials were mixed in a plastic bowl and stirred vigorously until a sol is observed. The processes was observed closely and recorded.

Statistical Analysis

Data from the Product Assessment Form distributed to practicing Dental Technologists in Enugu State who are the end users of starch separating medium were presented using frequency tables and percentages, and figures, and analyzed using SPSS Statistics version 20®.

RESULTS

Production of dental separating medium using tapioca extracted from *Manihot exculenta* in the Chemistry Laboratory of Federal College of Dental Technology and Therapy, Enugu was done in three (3) experimental stages using starch, glycerin, ethyl alcohol, coloring agent and distilled water,.

Tables 1, 2 and 3 below present the experimental materials and quantity, procedures and observations of the three (3) phases of experiment in the production of starch separating medium.

Table 1: Experiment I

Experiment Procedures	Observations
5000ml of cold distilled water was first poured in a measuring beaker, followed by 1000ml of glycerin and stirred for 30 seconds and was left to stand for 24 hours	There was a homogenous mixture and the mixture was colourless with no odour. After 24 hours, it was observed that the mixture remained consistent.
Adding 500ml of coloring agent (fuchsia pink) to the mixture and stirred for one minute.	The mixture was still homogenous. The colour of the solution changed from being colourless to pink.
400grams of starch flour was weighed and poured into a plastic bowl and gently the solution (distilled water, glycerin, ethyl alcohol, colourant) were poured into the bowl and vigorously stirred for about 10 minutes	The resultant mixture was observed to dissolve but not uniformly to form a sol and less viscous solution.
The product was applied to the surface of a model and cold cure acrylic resin was applied	It was observed that at the end of the process, there are patches of plasters particles on the self-cured acrylic.

Table 2: Experiment II

Experiment Procedures	Observations
4000ml of cold distilled water was first poured in a measuring beaker, followed by 1000ml of glycerin and 1000ml of ethyl alcohol and stirred well for 30 seconds and was left to stand for 24 hours	There was a homogenous mixture and the mixture was colourless but with a slight characteristic odour. After 24 hours, it was observed that there was a consistence mixture
Adding 500ml of coloring agent (fuchsia pink) to the mixture and stirred for a minute, then add 1000ml of distilled boiled water at 100^{0}c to the solution	The mixture was still homogenous but at this time warm. The solution changed from being colourless to pink colour
800grams of starch flour was weighed and poured in a plastic bowl and gradually the solution (cold distilled water, glycerin, ethyl alcohol, colourant and distilled boiled water) were poured into the bowl and vigorously stirred for about 10 minutes	The resultant mixture was observed to dissolve uniformly to form a sol and less viscous solution with a slight antiseptic smell.
The product was applied to the surface of a model and cold cure acrylic resin was applied	It was observed that at the end of the process, there are patches of plasters particles on the self-cured acrylic.

Table 3: Experiment III

Experiment Procedures	Observation
3000ml of cold distilled water was first poured in a measuring beaker, followed by 500ml of glycerin and 500ml of ethyl alcohol. All contents were stirred for 30 seconds and was left to stand for 24 hours	There was a homogenous mixture and the mixture was colourless but with a slight characteristic odour. After 24 hours, it was observed that the mixture still had consistence mixture
Adding 500ml of coloring agent (fuchsia pink) to the mixture, and stirred for one minute and another 1000ml of hot distilled water at 100^{0}c to the solution and continued stirring for about 10 minutes	The mixture was still homogenous but warm. The colour of the solution changed from being colourless to Pink.
1200 grams of starch flour was weighed and little was poured in a plastic bowl and gently the solution (cold distilled water, glycerin, ethyl alcohol, colourant and hot distilled water) was poured into the bowl and vigorously stirred as the starch was subsequently introduced at intervals.	The resultant mixture was observed to dissolve uniformly to form a sol and viscous solution with a slight antiseptic smell.
The product was applied to the surface of a model and cold cure acrylic resin was applied	It was observed that at the end of the process, there are patches of plasters particles on the self-cured acrylic.

Figure 2: Produced Dental Starch Separating Medium

Part B: Quality Control Assessment using Evaluation Sheet

Socio-demographic characteristics

Table 4 presents the socio-demographic characteristics of study respondents. As seen, a total of 20 practicing Dental Technologists were involved in the study of which 16 (80%) were males while 4 (20%) were females. Amongst the respondents, 10 (50%) had basic qualification (HND/BSc) while 10 (50%) had different higher educational qualifications. Similarly, the post-qualification experience of respondents show that practitioners of 5 years and below were 2 (10%); 6 – 10 years were 3 (15%); 11 – 15 years (25%); 16 – 20 years were 3 (15%); 21 – 25 years were 5 (25%), and above 25 years were 2 (10%).

Product Evaluation characteristics

Tables 5, 6 and Figures 3 and 4 show the results of the properties/characteristics of the product (Starch Separating medium) in terms of Flow ability, Colour stability, smoothness and effectiveness respectively.

Flow ability of the product

Table 5 showed that 8 (40%) evaluted the product as excellent; 3 (15%) very good; 5 (25%) good; and 4 (20%) adjudged it average.

Colour Stability of the product

As seen in Table 6, 10 respondents (50%) separating medium be excellent in colour stability while 5 (25%) adjudged it to be very good; similarly, 4 (20%) evaluated it as good, and 1 (5%) assessed it as being average.

Smoothness of the product

As presented in Figure 3, four (4) 20% of the respondents evaluated the separating medium to be excellent; 8 (40%) as very good; 7 (35%) good; 2 (10%) average; and 2 (10%) poor.

Effectiveness of the product

Figure 4 presents the assessment of the effectiveness of the separating medium as 8 (40%) of the respondents evaluated the separating medium excellent; 7 (35%) very good, 2 (10%) good, 2 (10%) average and 1 (5%) as being poor.

Table 4: Socio-Demographic characteristics of Practicing Dental Technologists

Variables	Frequency	Percentage
Sex		
Male	16	80
Female	04	20
Age group		
<26yrs	02	10
26-35yrs	06	30
36-45yrs	05	25
46-55yrs	04	20
56-75yrs	03	15
Marital status		
Single	04	20
Married	16	80
Widow	00	00
Widower	00	00
Level of Education		
PhD	00	00
MSc	05	25
PGD	05	25
HND/BSc	10	50
Years of Experience		
< 5yrs	02	10
6-10 yrs	03	15
11-15 yrs	05	25
16-20 yrs	03	15
21- 25 yrs	05	25
>25 yrs	02	10

Table 5: Evaluation of the Flow ability of the product

Flow ability	Frequency	Percentage (%)
Excellent	8	40
Very good	3	15
Good	5	25
Average	4	20
Poor	0	00

Table 6: Evaluation of the Colour stability of the product

Colour stability	Frequency	Percentage (%)
Excellent	10	50
Very good	5	25
Good	4	20
Average	1	5
Poor	0	0

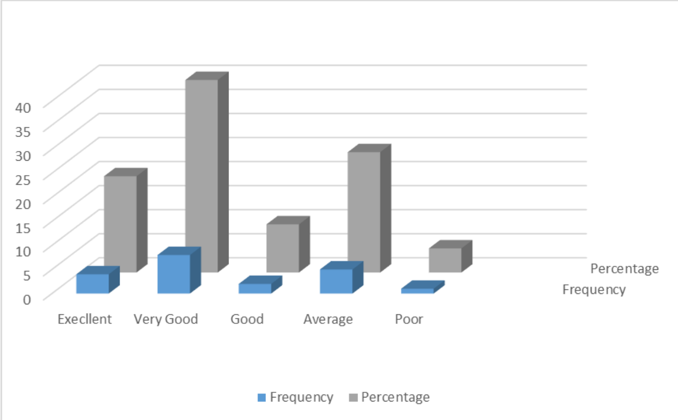

Figure 3: Evaluation of the smoothness of the product

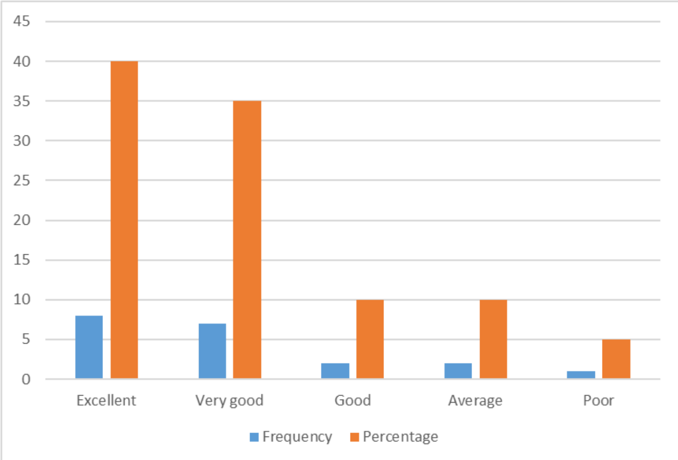

Figure 4: Evaluation of the Effectiveness of the product

DISCUSSION

This study carried out in Chemistry Laboratory of Federal College of Dental Technology and Therapy, Enugu provides information on production of separating medium using tapioca extracted from *Manihot exculenta* in Enugu, Nigeria. And the findings are discussed below;

Flow ability of the product: The results of the flow ability as shown in Table 5 indicate that the locally produced starch separating medium is good and can flow easily on the model. The material filled the pores / surface forming tin film on the surface of plaster mould. This is in agreement with [10, 31, 32].

Colour Stability of the product: The appropriate quantity of the raw materials which were 1200g of starch flour, 500ml of glycerin, 500ml of ethyl alcohol, 4000ml of distilled (hot and cold) water and 500ml of coloring agent adjudged to be good by end users is in consonance with [13, 29, 30].

Smoothness of the product: This is a factor for consideration in ensuring good patterns for acrylic resin dentures and other materials in dental technology practice. This patterns are translated into finished work. The results of this study indicate that locally *Manihot esculante* starch based separating medium is smooth enough to produce fine details of prostheses. This results effect is consistent with the work of [11, 30, 33, 34].

Effectiveness of the product: This remains a vital aspect of the product evaluation. The result of this study shows Tapioca based starch separating medium is effective as (40)% of the respondents who are the end users responded excellently to the product. Which is in line with the study conducted [11, 14, 31, 35] where cold mould seal material as separating medium revealed highly effect on the compressive strength of cold cure acrylic resin denture base material.

This study is a pilot study and it is believed that if the project is developed further, Starch separating medium can be locally produced in large quantity in Nigeria. The resultant effect of this is availability of the product, affordability of the product, job opportunity and advancement of Dental Technology practice in Nigeria and West Africa as a whole since Federal College of Dental Technology and Therapy, Enugu have been the hub of Dental Technology training in Africa.

CONCLUSION

The results of this study indicate high potential and possibility of producing *Manihot esculante* extracted based separating medium locally sourced materials. The quality of the produced dental separating medium is of high quality and comparable standard to the imported commercial ones. The ready availability of materials, instruments and equipment, knowledge, and application of the known principles and procedures will go a long way to make Nigeria independent and self-sufficient in dental separating media. Results showed that with the combination of the right principles and materials to locally produce dental separating medium aligns with Nigeria's sustainable development plan.

Authors' Contributions

PCO conceived the study, designed the study and involved in drafting of the manuscript; EOO participated in the purchase of the raw materials, experiments and collection of data; JE was involved in study design and supervision of the study; KNO supervised the experiment, drafting of the manuscript and statistical analysis; CSmO was involved in the experiment and supervision of data collection. All authors read and approved the final manuscript.

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Competing Interest

The authors declare that they have no competing interests

Availability of data and materials

The datasets used and /or analysed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable

Ethics approval and consent to participate

The experiment was carried out in accordance with the approval of the Ethics Committee of the department of Dental Technology, Faculty of Health Technology and Engineering, Federal College of Dental Technology and Therapy, Enugu, Enugu State, Nigeria, and all in accordance with the ethical standards laid down in the 1964 as amended in 2000 Declaration of Helsinki. Informed concept was signed by all the evaluating participants (Dental Technologists) before they were allowed to evaluate the product.

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REFERENCE

1. Kouakou J, Nanga SN, Ismail CP, Pali AM, Ognakossan KE. Cassava production and processing. The Pro-Agro Collection publication and he Technical Centre for Agricultural and Rural Cooperation, 2016.
2. Adebowale AA, Sanni LO, Onitilo MO. Chemical composition and pasting properties of tapioca grits from different cassava varieties and roasting methods. African Journal of Food Science. 2008; (2):077-082. Retrived from http://www.academicjournals.org/ajfs on 12/03/2019.
3. Food and Agricultural Organisation. Cassava Starch. Food and Agricultural Organisation of the United Nation, 2017. Retrieved March 24, 2019 from http://www.fao.org/docrep/x5032e/x5032E06.htm.
4. Simone-de SM, Laís MR, Ryziade-Cássia VC, Geany PC, Renato SC. Tapioca and Rice flour cookies: Technological, Nutritional and Sensory Properties. Ciênc. Agrotec. Lavras. 2015; 39(5):514-522.
5. Moller M. Manihot Esculenta. Colegio Boliva, Cali Colombia, 2018.
6. Fern K. *Manihot esculenta*, 2017. Retrieved March 24, 2019 from http://tropical.theferns.info/viewtropical.php?id=Manihot%2Besculenta
7. Darcy Zani. A comparative study of silicon as a separating medium for denture processing. Journal of Prosthetic Dentistry. 1979; 42(4):386-391.
8. Barclay CW, Walmsley AD. Fixed &Removable Prosthodontics, Acrylic Denture, 2nd ed., 1998; 71- 80.
9. Kadir SK, Hama-Saeed NH, Hanna BA. Studying the Effect of Different Separating Medium on the Roughness of the tissue surface of Acrylic Denture Base (In Vitro Study). Iraq. National Journal of Nursing Specialties. 2012; 25(1):89-94.
10. Machado AL, Breeding LC, Vergani CE, da cruz LE. Hardness and surface roughness of reline and denture base acrylic resins after repeated disinfection procedures. Journal of Prosthetic Dentistry. 2009; 102(2):115-22.
11. Ali SD. Effects of three different types of separating medium on the compressive strength of cold cure acrylic Resin. Journal of Kerbala University. 2011; 9(3):208-215.
12. Nihad HM. The Effect of Different Types of Separating Medium On The Hardness of Different Types of Heat-Cure Acrylic Resin Materials. Medical Journal of Babylon. 2014; 11(3):590-598.
13. Al-Jubouri O, Azari A. Evaluation the effect of different types of separating medium on color stability of heat-cure acrylic resin "A comparative study*".* Journal of Chemical and Pharmaceutical Research. 2015; 7(7):1013-1019
14. Craig RG, Power JM. Restorative Dental Materials. Polymer & Polymerization., 11th ed St. *Loui Mosby Co.,* 2002.
15. Thana M. Dental products, Indian Mark Member Science. 2002; (13)1.
16. Brisk JB. Fixed Prosthodontics. 6th edition. Staples Press. 2007; 227-278.
17. Raja MA. Evaluation of glycerin as a separating medium for processing acrylic denture base materials. Thesis submitted as partial fulfillment for master degree, 2005.
18. Alexander JM, Pascal JJ. Effect of Gypsum Separating Medium on Acrylic Resin, (3rd edition). Medical Journal of prosthetic Dentistry. 2009; 28:557.
19. Akhlas ZA. Evaluation of olive oil as a separating medium & its effect on some physical & mechanical properties of processed acrylic resin denture base, 2009.
20. Taylor NO, Paffenbarger GC, Sweeney WTA. Specification for separating medium. Journal of American Dental Association. 2013; 40-52.
21. Graham H. Toxicology and Applied Pharmacology. Journal of Agricultural and Food Chemistry. 2004; 73(2):55-63.
22. Soap and Detergent Association. Glycerine: an overview. Glycerine & Oleochemical Division, New York, 1990.
23. Harrison K. Toxic and Hazardous Industrial Chemicals. *The American Chemical Society and the American Institute of Physic*s, 2004.
24. Gilda G. Dehydration of Aqueous Solution. *American Chemical society.* 2004; 21(8):193-198.
25. Osborne O. Animal Inhalation Studies on Ethylene Glycerol. *The Pharmacological basis of therapeutics Publishers,* New York City, 2007.
26. Johnson C. Restorative Dental Materials (10th edition). Journal of Prosthodontics Dentistry. 2007; 85(4):4-8.
27. Paul J, Boleyn M, Fredrick T. Toxicology and Applied Pharmacology. Journal of Agricultural and Food Chemistry. 2011; 1(2):13-19.
28. Andrew AA. Odorant Chemicals. Journal of Air Pollution Control Association. 2008; 40(3):184-195.
29. Canadas MD, Garcial LF. Color stability, surface roughness & surface porosity of acrylic resin. Journal of Prosthetic Dentistry. 2010; 19(1):52-7.
30. Okorie PC, Emaimo J, Aleke CO, Okoronkwo SC, Nwangwu G, Okeke KN, *et al*. Production of Dental Inlay Wax Using Locally Sourced Materials in Enugu, Nigeria. International Journal of Dental Medicine. 2019; 5(1):1-8.
31. Manapalli JA. Material Science Technology. Journal of prosthodontics Dentistry. 2013; 10(7):50-61.

32. Wilson BM, Adlard SA, Michael ME. Skinner's Science of Dental Materials. Journal of American Dental Association. 2009; 4(17):168-180.
33. Anusavice JK. Science of Dental Materials. (10th edition). London E.B. *Saunders Company, London,* 2011.
34. Scott B, Clifford LC. Modification of Separating Medium used in Flasking Dentures. (5th edition). *Philadelphia WB Saunders CO*. 2005; 31-57.
35. Bryan VO. Food and Cosmetic Toxicology. Journal of investigative Dermatology. 2006; 46(1):49-55.