IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Research Article
January 2021 Vol.:17, Issue:3

Peeling of Babassu Coconut by Microwave

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Submitted: 01 December 2020
Revised: 20 December 2020
Accepted: 10 January 2021

Keywords: Microwave, ductility, peeling, babassu coconut.

ABSTRACT

This work proposes the use of microwaves in the processing of babassu coconut peeling. The babassu is a palm tree, originating from the biomes of the Amazon, Atlantic Forest, and Cerrado covering over twenty-five million hectares, with impact financial, social, and ecological in the life of more the three hundred thousand local families from North, Northeast, and Midwest regions of Brazil. The workers of Babassu coconut the overwhelming majority of cases are women. These women are active in the breaking, processing, and commercial of the product, with low productivity and efficiency. From the use of electromagnetic waves in the process of peeling coconut, it is possible to increase productivity with better use of the peel and epicarp of the fruit, which has an economic value in the production of a nutritious flour marketed in several localities. The advantage in using microwaves is the reduction of the ductility of the epicarp of babassu, to the point of breaking it with your hands, something which requires over twenty tons of force per square inch in the fruit in nature. For the tests performed, the best results were two 180-second periods, with a 30-second rest, at the highest power of the magnetron. From the results, it can be considered that the process can be used for the processing of the fruit with better use of its parts, improving productivity.

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I. INTRODUCTION:

Babassu coconut is the palm tree of the family *Arecaceae*, knowledge in scientific researches as *Orbignya phalerata* and *Attalea speciosa*. The fruit is most used by Amerindians and the rural population in the Amazon, which is native to Brazil's North, Northeast, and Midwest, including the Amazon, Atlantic Forest, and Cerrado biomes. The palm tree covers over 25 million hectares (96,526 square miles), in the North, Northeast and Midwest regions of the Brazilian, in states of Piauí, Maranhão, Tocantins, and Pará. A population of over three hundred thousand families' lives from the processing of the different parts of the fruit, with 102,000 tons of babassu kernels was commercialized in Brazil [1-4].

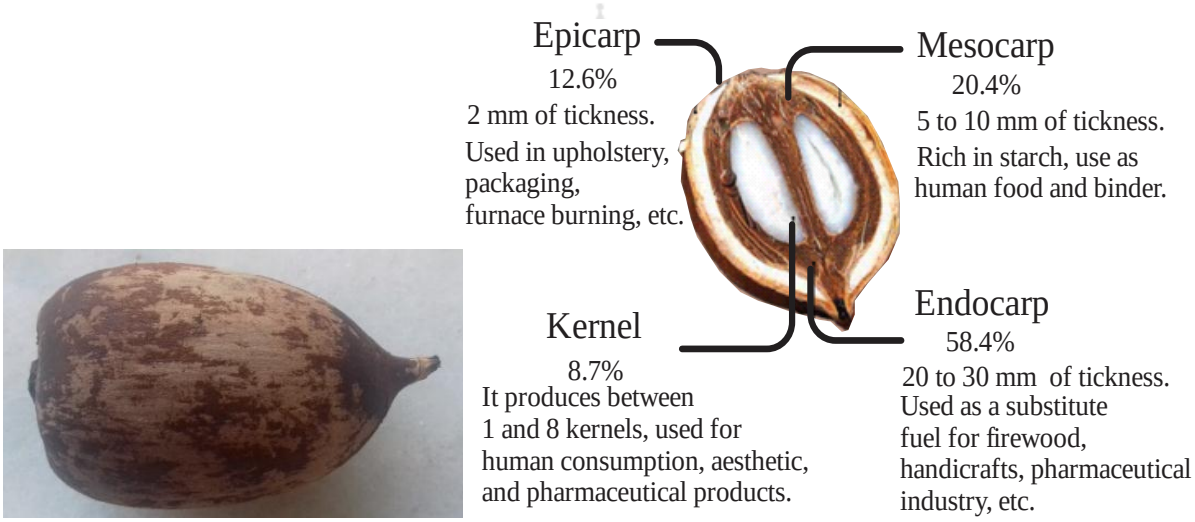
F From the 1950 decade were performed government research and incentives for the development and beneficiation of babassu producing regions [5]. In 2017, at least 300,000 families were identified working as babassu coconut breakers, and with the kernel oil production, in the state of Maranhão (Brazil) alone. Even with all 21st-century technological development, the reality of thousands of families is still manual production with features similar to the 1950s [6].

The microwave is using in food processing since the 1950s in industrial and personal applications. According to [7], its application includes "*tempering, vacuum drying, freeze-drying, dehydration, cooking, blanching, baking, roasting, rendering, pasteurization, sterilization, and extraction*" [7-10]. In [11] was performed an investigated the trend of structure and dielectric properties during microwave freeze-drying process banana chips. The work of [12] was evaluated the effect of microwave heating of wheat grains on the browning of dough and quality of chapattis, concluding that the microwave heating controlled the enzymatic browning in the dough. A study of the power absorption and temperature distribution by microwave applied to the reheating of instant rice was developed by [13]. Other works have developed numerical methods and simulations for better uses of electromagnetic waves, in a range of microwaves in food [14-15]. In the work of [16], the dielectric characterization of the Tommy mango was performed out, by electromagnetic waves, to show the time of internal ripening of the fruit, optimizing the logistics for better use of the product.

This paper is developed of peeling babassu coconut with reduction of ductility of the fruit by electromagnetic waves, in the microwave's range, for fruit processing. This paper is composed of three more parts beyond this introduction. Section II presents the materials, methods, and theoretical fundamentals used in the development of the work. Results and discussions are presented in section III, and section IV shows the final considerations.

II. MATERIALS AND METHODS

Babassu consists of four parts: epicarp, mesocarp, endocarp, and kernel, the parts are used in several applications, the mesocarp and kernel in human alimentation, the epicarp in furnaces for their high burning factor, and the endocarp in the production of charcoal [3-5]. Fig. no.1 shows the babassu coconut with the respective percentages and approximate thickness of each part, adapted from [5], [17].



(a) (b)

Figure No. 1: Babassu coconut: a) external vision; b) internal vision.

- Epicarp is a very rigid fibrous compound that requires a lot of effort to be removed;
- Mesocarp, non-fibrous layer, used for human consumption;
- Endocarp, fibrous and rigid layer that serves as a shell for almonds;

- Kernel, the noblest part of the fruit, with various applications such as food, medicine production, and aesthetic products.

Babassu is a fruit from which all layers can be used for many different applications [1-5]:

- Pharmaceuticals, with products for the treatment of various pathologies;

- Human feed, using the mesocarp and the kernel;

- Artisanal production of epicarp and endocarp;

- Substitutes of industrial products such as Styrofoam, glue, fuel, etc.;

- Aesthetics, with the use of kernel oil in soaps, creams, body oils, among others.

The babassu peeling by electromagnetic waves was performed at the Signal Acquisition and Processing Laboratory (LAPS) of the State University of Maranhão (UEMA), Campos I, São Luís–MA, Brazil, using the commercial microwave, with the low-cost commercial device, operating in the 2.45 GHz range, with a voltage of 400 V, with a power ranging from 900 W to 1100 W. The magnetron emits high power non-ionizing waves through a coupled antenna. Energy over a medium causes the molecules to vibrate, warming material with conductivity (σ), which can reduce the fruit's ductility, making it easier to peel. [18-19].

An important factor in using electromagnetic waves is the penetration of the wave into the material. With babassu, the parts of the fruit are susceptible to wave incidence, i.e. the electromagnetic wave acts on the fruit layers, being linked to the wave penetration depth, skin effect (δ). This effect is observed in materials that have conductivity (σ), being a function of the resonance frequency (f) of the radiator and the magnetic permeability (μ) of the medium, with wave penetration depth given by:

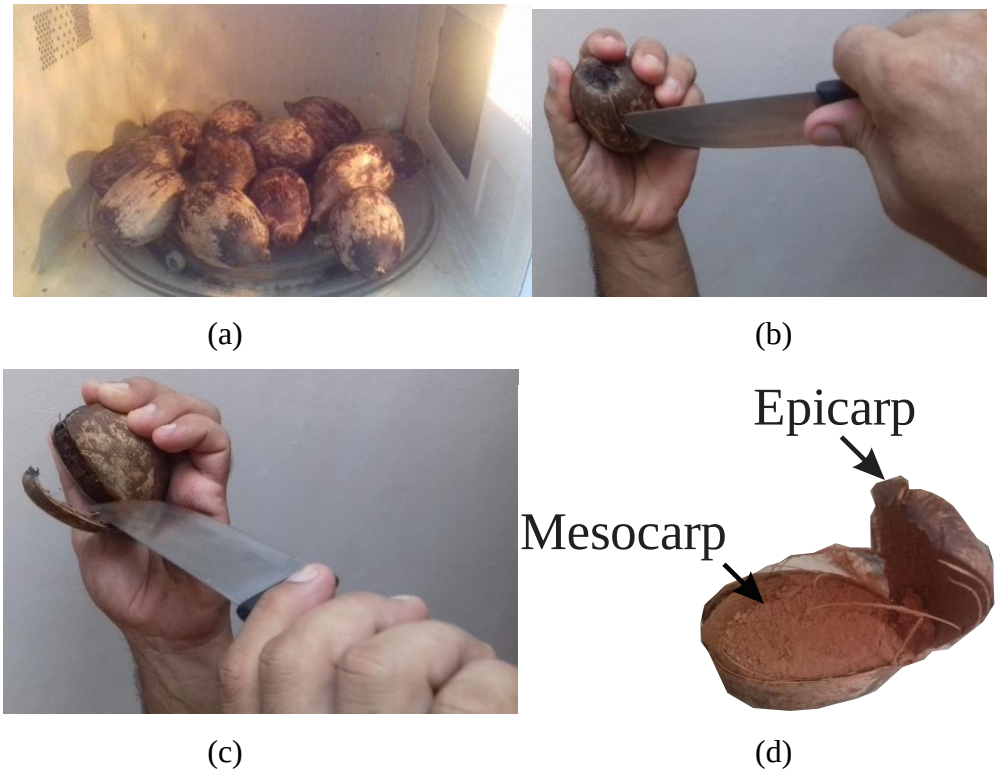
$$\delta = \frac{1}{\sqrt{\pi f \mu \sigma}}, \qquad (1)$$

The assumption for the use of electromagnetic waves in babassu peeling is that the shell is not a perfect dielectric, having conductance and that on the incidence of the wave the epicarp must change its structure, being susceptible to breakage more easily, that is, the ductility of the fruit to

be reduced. Another advantage of electromagnetic waves in the microwave range is that in this frequency range (0.3 GHz - 300 GHz), the waves are considered non-ionizing, not promoting the alteration of the materials that receive their energy [7-8].

III. RESULTS AND DISCUSSIONS:

Fig. no. 2 presents the test of the use of electromagnetic waves in babassu peeling. As observed in Fig. no. 2(a) the fruits are arranged in the microwave device without special order or criteria. Several tests were performed until the best results were reached. For best results, the maximum power of magnetron was used in two time periods, with an incidence of 180s, a delay of the 30s, and a new incidence of 180s. From the use of the technique, it is possible to remove the epicarp without loss of the mesocarp and can be fully used, promoting gains in product quality and quantity. This can be verified by the results obtained in the tests performed and visualized in Fig. no. 2(b), and Fig. no.2(c), with the result, shows in Fig.no. 2(d).



(a) (b)

(c) (d)

Figure No. 2: Process of the use of electromagnetic waves in the babassu peeling: a) arrangement of fruits in the microwave; b) aperture of the fruit; c) peeling; d) open fruit with the indication of the epicarp and mesocarp.

The process promotes the removal of water from the fruit, especially in the outer parts. This characteristic makes the epicarp more ductile, facilitating its removal. The mesocarp is also benefited by the process, because the product will be with lower humidity, which facilitates producing mesocarp flour, without altering its characteristics.

One difficulty of the project is the irradiated power combined with the wave incidence time since the babassu parts do not yet have the dielectric characterization, the tests were done with different incident powers and a different time. Finding a parameter of the optimal power/time ratio for peeling is critical to the process, by the longer incidence time of the electromagnetic wave promotes the burning of kernels, because the wave goes through the epicarp, mesocarp, and endocarp, causing the kernel to vibrate, and it heats, reaching full burning. In this process, the kernel releases part of its oil, which spreads through the endocarp speeding up burning the fruit. Thus, the permanence time under the electromagnetic wave and the power of the magnetron is essential in the project's execution. The permanence of the babassu under the wave for an excessive period promotes the burning of the fruit from the inside out, and without adequate time there not the reduction of the ductility of the epicarp of babassu coconut.

It was also found that the arrangement and number of fruits in the device did not influence the last result. Here, it can be verified that the wave hits both the epicarp and the kernel, with the possibility of burning in the kernel. From the observed results, it can be considered that the use of electromagnetic waves, in the microwave range, in the peeling of babassu coconut, can be used for the processing of the fruit with better use its parts, with commercial devices, with no adaptations for use, by the low-cost process.

IV. FINAL CONSIDERATIONS:

In this work, was presented a method of the peeling of the babassu coconut by electromagnetic waves, operating in the range of microwaves, and low-cost processes. The difficulties of using electromagnetic waves in peeling are about the time of the incident of the electromagnetic wave on the fruit. Staying for a brief period does not allow fruit peeling and staying by exceeding time promotes the burning of the kernels. From the results presented, it was possible to evaluate that the use of electromagnetic waves is a viable possibility to the reduction of ductility of fruit, and easy peeling. For best results, the maximum power of magnetron was used in two times, with an

incidence of 180s, a delay of 30s, and a new incidence of 180s. From the observed results, it can be considered that the process can be used for the processing of the fruit with better use of its parts, improving productivity.

ACKNOWLEDGMENT*:*

We greatly appreciate the FAPEMA Process BAI-06776/18 – EDITAL Nº 028/2018 - IECT BABAÇU - BAI, UEMA, IFPB, FAPESQ and COUPLE/UFCG, by supporting and funding this project, without which this work would not be possible.

REFERENCES*:*

1. Silva VC, Barboza JR, Richard P, Batista MCA, Veras KS, Godinho JWL, Mesquita JWC, Mesquita LSS, Marinho FMM, Ribeiro MNS. Indentification of phenolic compounds by LC/MC-MS and antioxidant and anti-tyroninase activities of the Attalea speciosa Mar. ex Spreng. Mesocarp. Journal of Chemical and Pharmaceutical Research Research. 2017; 45:268-276.
2. Araujo FR, Gonzales-Perez SE, Lopes MA, Viegas IJ. M. Ethnobotany of babassu palm (Attalea speciosa Mart.) the Tucurui lake protecte areas mosaic – eastern Amazon. Acta Botanica Brasilica. 2016;30(2):193-204. https://doi.org/10.1590/0102-33062015abb0290.
3. Ferrari RA, Soler MP. Obtention and characterization of coconut babassu derivatives. Scientia Agricola. 2015;72:291-296.
4. Cavallari MM, Toledo MM. What is the name of the babassu? A note on the confusing use of scientific names for this important palm tree. Rodriguésia. 2016;67(2):533-538. https://doi.org/10.1590/2175-7860201667218.
5. Valverde O. Geografia Econômica e social do Babaçu no Meio Ambiente. Revista Brasileira de Geografia. 1957;4:381-420.
6. Silva EMS, Napolitana JE, Bastos S. Pequenos Projetos Ecossociais de quebradeiras de coco babaçu: reflexões e aprendizados. Brasília: ISPN, 2016.
7. Orsat V, Raghavan GSV, Krishnaswamy K. Microwave technology for food processing: an overview of current and future applications. In: The Microwave Processing of Foods. 2nd. (edited by M. Regier, and K. Knoerzer, H. Schubert). London, UK: Elsevier. 2017;100-116.
8. Datta AK, Anantheswaran RC. Handbook of Microwave Technology for Fook Applications. New York, USA: Elsevier. 2001.
9. Zidane F, Lanteri J, Marot J, Brochier L, Joachimowicz J, Roussel H, Migliaccio C. Nondestructive Control of Fruit Quality via Millimeter Waves and Classification Techniques: Investigations in the Automated Health Monitoring of Fruits. IEEE Antennas and Propagation Magazine. 2020;62(5):43-54. https://doi.org/10.1109/MAP.2020.3003222.
10. Vasquez JAT, Scapaticci R, Turvani G, Ricci M, Farina L, Litman A, Casu MRC, Crocco L, Vipiana F. Noninvasive Inline Food Inspection via Microwave Imaging Technology: An Application Example in the Food Industry. IEEE Antennas and Propagation Magazine. 2020;62(5):18-32. https://doi.org/10.1109/MAP.2020.3012898.
11. Jiang H, Zhang M. Changes of microwave structure/dielectric properties during microwave freeze-drying process banana chips. International Journal of Food Science + Technology. 2014;49:1142-1148. https://doi.org/10.1111/ijfs.12410.

12. Yadav DN, Patki PE, Sharma GK. Effect of Microwave heating of wheat grains on the browning of dough and quality of chapattis. International Journal of Food Science + Technology. 2008;43:1217-1225. https://doi.org/10.1111/j.1365-2621.2007.01593.x.
13. Fan D, Li C, Ma W, Zhang H, Chen W. A study of the power absorption and temperature distribution during microwave reheating of instant rice. International Journal of Food Science + Technology. 2008;47:640-647. https://doi.org/10.1111/j.1365-2621.2011.02888.x.
14. Halkman HBD, Yücel PK, Halkman AK. Non-Thermal Processing - Microwave. (editors: Batt, C. A., and Tortorello, M. L.). In: Encyclopedia of Food Microbiology, 2nd. Academic Press. 2014:962-965. https://doi.org/10.1016/B978-0-12-384730-0.00400-6.
15. Punathil L, Basak T. Fundamentals of Microwave Processing of Food Materials: Modeling and Simulation Methods. Reference Module in Food Science. Elsevier. 2017. https://doi.org/10.1016/B978-0-08-100596-5.21842-8.
16. Silva Junior P F, Santana EEC, Pinto MSS, Andrade EP, Carvalho JN, Freire RCS, Oliveira MA, Oliveira EEC. Characterization of the Dielectric Properties of the Tommy Atkins Mango. Journal of Microwaves, Optoelectronics and Electromagnetic Applications. 2020:19(1):86-93. https://doi.org/10.1590/2179-10742020v19i11868.
17. Carrazza LR, Avila JCC, Silva ML. Manual Tecnológico de Aproveitamento Integral do Fruto e da Folha do Babaçu. 2nd. ISPN. 2012. https://sgp.undp.org/publications-188/518-brazil-technological-manual-for-utilization-of-babacu/file.html+&cd=1&hl=pt-BR&ct=clnk&gl=br&client=firefox-b-d. Accessed 22/12/2020.
18. Sadiku MO. Elements of Electromagnetism. New York: Oxford University Press. 2014
19. Hayt W. Engineering Electromagnetics. 8nd. New York: MvGraw-Hill Science. 2011.

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