Coconut Testa as a Functional and Healthy Ingredient in Food Products: A Review

H.N. RAMYA, S.R. SANTHOSH KUMAR, SHIVABASAPPA KANDKUR
Agriculture College, Hassan
Karekere, Hittalaladahalli, Karnataka 573225, INDIA

Abstract: The brown skin covering the coconut kernel is testa, mainly a by-product from the coconut processing industry is getting wasted. During the reparation of desiccicated coconut, coconut milk and virgin coconut oil the testa is removed by paring the dry/ wet coconut as it imparts a brown colour to the oil and a dull appearance to other products. As the coconut matures the thickness of the testa increase and gives brown colour to the bottom layer of the kernel. Coconut testa contained more of natural antioxidants such as tocopherols, tocotrienols and phenolics compared to coconut kernel oil and may confer health benefits. Presence of phenolic compounds is mainly responsible for the antioxidant properties of virgin coconut oil. The final phenolics content of coconut oil depends on the components of the endosperm. Information on the components of coconut testa is rare. Therefore, Coconut testa can be utilized in food products to improve their health benefits and commercial values. This review focuses on the current food applications and influence of coconut testa on the characteristics of various food products.

Keywords: Coconut Testa, Food Processing Wastes, Functional Ingredients, Nutritional Value

Received: June 14, 2022. Revised: October 14, 2023. Accepted: November 18, 2023. Published: December 29, 2023.

1. Introduction

The coconut [Cocos nucifera (C. nucifera) L.] is an important fruit tree in the world, providing food for millions of people, especially in the tropical and subtropical regions and with its many uses it is often called the “tree of life”. Coconut testa is an important byproduct of the coconut industry. According to current practice, removal of testa takes place after deshelling the coconut, done manually using paring knives (Marikkar and Madurapperuma, 2012). Coconut testa is locally available in Indian states like Kerala, Tamil Nadu, etc from the economic and environmental point of views, with the large availability and the composition that always rich in bioactive compounds, reutilization of these wastes for the production of beneficial products would be effective in terms of cost and environmental pollution (Jamaluddin et al., 2016). Its utilization is very limited despite being a good source of secondary metabolites such as polyphenolic constituents. tocopherol and tocotrienols, which may provide health benefits to human (Oliveira et al.,2011). According to the latest statistics, several thousand tons coconut testa are produced in SriLanka annually and they are usually used as animal feed and sometimes use to extract oil for cosmetics. According to Appaiah et al. (2014), coconut testa coming from desiccated coconut industry is rich in fat and it is about 34.7% in wet weigh basis. Currently, over 150 desiccated coconut powder production units are present in india, of which the total production

capacity of all the production units would come around one lakh metric tones. Testa contains oil and has a bitter taste due to polyphenols and is used as animal feed. The polyphenols have antioxidant properties and hence, the natural antioxidant concentrate can be prepared from coconut testa can be incorporated as an ingredients in foods. The production of testa waste is still more and hence needs alternative way to reuse it as valuable products. Currently, coconut testa is used as a functional ingredient in food products due to its high nutrient Content. Most of the previous reviews on utilization of coconut testa have been focused on the recovery of functional anti-axident activity compounds from coconut testa and applications of these compounds in various nutraceutical products. However, there is an increasing interest in utilizing coconut testa directly or with minimal processing in food products.

2. Composition and Nutritional Value of coconut testa

Proximate composition of dry and wet coconut testa has been reported in various studies (Prakruthi Appaiahet al.2014). Difererent physical–chemical compositions of Copra testa had been moisture 3.6-4.3 %, Moisture is the most abundant component of most plant foods and is also a crucial factor to determine the shelf life stability of processed products (Coultate, 2009), fat 59.0-63.6%, Dietary fat or lipid is one of the most important macronutrients that provides energy and essential fatty acids to various functions of the human body (Raihana*et al.*, 2015). Fat contents of food usually vary from very low to high depending on the source of origin, variety, geographical location, etc. (De Man, 1999). According to Najwa *et al.* (2017), the fat content of defatted coconut residue left after extraction of coconut milk was found to be 17.26 %. Protein 8.1-10.2 %, Proteins are the third most abundant class of macromolecules in food systems; they perform numerous biological functions in living systems (Chang, 1998). Previous researchers have examined the protein content of defatted coconut flour obtained from the whole endosperm, but not the protein content of the testa. In an early report, Ediriweera and Kashizumi (1991) pointed out that the whole endosperm of fresh coconut has about 4 % protein and the value might increase in defatted meals after extraction of milk. In a study on mixed coconut types, Yalegama and Chavan (2006) found that coconut flour obtained after oil extraction of the whole kernel has around 18 to 20 % of protein. Carbohydrates 22.4-26.3%, Total carbohydrates consist of multiple nutrients, which include dietary fibre, sugars and starches The carbohydrate content of coconut testa flour is generally lower than that of traditional grain flours such as wheat flour. Kassegn (2018) reported that100 g of wheat flour might contain around 64–72 g of carbohydrates while David *et al*. (2015) found that the total carbohydrate content of soft wheat flour was around83 %. According to previous reports of Yalegama and Chavan (2006), the total carbohydrate content of coconut flour was around 50 %. In a separate study, Beansch *et al*.(2004) also reported that the total carbohydrate content of defatted coconut flour obtained after the extraction of virgin coconut oil was about 52.0 % (w/w, dry basis). Ash 1.4-2.1% Ash is the composite material of minerals present in flour. Determination of the ash and mineral content of foods is important for a number of reasons. It is generally accepted that the ash content of flour does not affect the baking performance in majority of the cases (Borla *et al*., 2004). For instance, the ash contents of coconut residue samples obtained after milk extraction by two different machines were found to be1.5 % (Yalegama *et al*., 2013) and 0.54 % (Najwa *et al*.,2017). and potassium was

major mineral present at 120.3-124.1 mg%. Furthermore, its oil extract shown high antioxidant activity and well inhibition effect on oxidation of human low density lipoprotein (Zhao et al., 2012; Zhang etal., 2016).Therefore, coconut testa is of great nutritional value, providing health benefits. Several studies indicated that coconut testa. Development of flour out of coconut kernel has been the interest of researchers for preparation of snack foods (Yalegama *et al*., 2013), the studies on utilisation of coconut testa as a source of flour is scanty. The existence of these value-added compounds also indicates the potential of coconut testa being utilized as an ingredient in the food industry.

Fig. 1. a. Coconut b. Coconut to be deshelled c. Coconut meat with a layer of brown d. Testa of Coconut meat removed

3. Use of coconut testa as a Functional Ingredient in Food Products

Due to the high content bioactive compounds such as phenolics and flavanoids. It haspotential to be used as a functional ingredient by the foodprocessing industry. Although, development of flour outof coconut kernel has been the interest of researchers forpreparation of snack foods (Yalegama *et al*., 2013), thestudies on utilisation of coconut testa as a source of flouris scanty so we used as a good functional ingredient to be incorporated in various food products.

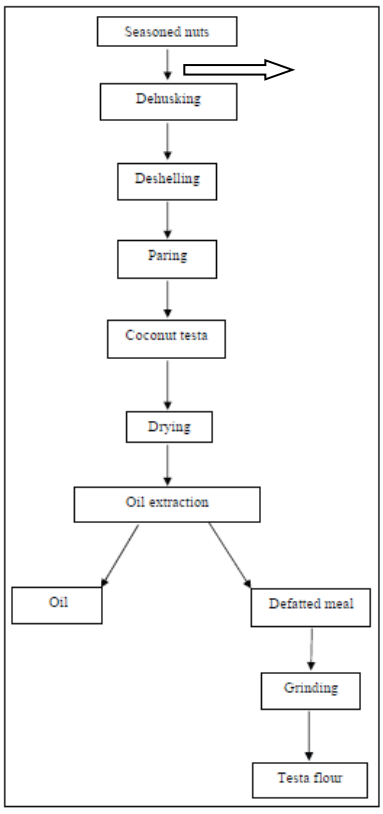

Figure 2: Process flow diagram for production of coconut testa flour

3.1. Bakery Products

The application of coconut testa in bakery foods is considered to improve the nutritive content and health benefits. Coconut testa flour have higher contents of protein and fat than wheat flour; hence partial substitution of wheat flour with coconut testa flour would improve the

nutritional quality offlour- based products.(Sanjila Marasinghe et al 2019). The protein content is an important parameter for bread making as flour containing higher Protein contents would be more expensive than flours of lower protein content. Another important feature of coconut testa flour is that its protein is gluten-free, which is advantageous for people with celiac disease or gluten intolerance. When compared with previous reports, the moisture contents of coconut testa flour used in this study were lower than those of commercial wheat flour (Nasir*et al*., 2003). Organisms naturally present in the flour start to grow at high moistures, producing off odours and flavours. Hence, Nasir *et al.* (2003) suggested that wheat flour having less than 10% moisture would be appropriate for extended shelf life. Further, more mold growth and insect infestation has been noticed in wheat flour having higher moisture during storage. Therefore, coconut testa is of great nutritional value, providing health benefits. Several studies indicated that coconut testa. Development of flour out of coconut kernel has been the interest of researchers for preparation of snack foods. All these findings suggest that coconut testa flour can become a potential source for value addition purposes and reduce the wastage of under-utilised coconut testa generated by the coconut processing sector.

4. Conclusion

The common disposal methods of coconut testa can cause environmental pollution and even public health hazards. These wastes can be used as supplementation in wheat-based baked products such as bread, cakes, biscuits, muffins, noodles, pasta etc. for the enrichment of the nutritional profile of the products. They would be a source of natural flavor and color in place of synthetic ones. These wastes would hence provide the majority of nutrients of coconut testa provide several health benefits, the functional property of foods and can also have a preservative effect.

Coconut testa is a by-product from desiccated coconut industry and it is used as animal feed mainly. Its utilization is very limited despite being a good source of secondary metabolites such as polyphenolic constituents. tocopherol and tocotrienols, which may provide health benefits to human (Oliveira et al., 2011).Therefore, recent trends in food and nutritional research are to identify antioxidants rich dietary sources, separation and purification of bioactives for the formulation of functional foods and nutraceutical preparations. Extraction is the initial and most vital step in the recovery and purification of bioactive compounds from plant sources and many factors such as solvent concentration; extraction temperature, solvent-to-solid ratio etc influence the extraction efficiency and bioactive concentration (Prasad et al., 2011). In general, coconut testa flour of all cultivars displayed higher contents of protein and fat than wheat flour; hence partial substitution of wheat flour with coconut testa flour would improve the nutritional quality of flour-based products. In general, coconut testa flour of all cultivars contained micro-minerals such as Mn, Cu and Zn (S.S.K. Marasinghe et al., 2019).The variety of food products that can be incorporated with coconut testa is relatively small. Therefore, more applications need to be explored in the future to solve the problem of excess coconut testa disposal in an environmentally friendly manner and to improve the quality and health aspects of a variety of food products by incorporation of this valuable functional ingredient.

Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

[1]. Appaiah, P., Sunil, L., Prasanth Kumar, P.K. andGopala Krishna, A.G. (2014).Composition of Coconut Testa, CoconutKernel and Its Oil. Journal of the American Oil Chemists' Society. 91(6):917-924. Cord 2018, 34 (2) 20.

[2]. Borla O.P., Motta E.L., Saiz A.I. & Fritz R.(2004). Quality parameters and baking performance of commercial gluten flours. *LWT- Food Science and Technology* **37**: 723–729.

[3]. DOI: https://doi.org/10.1016/j.lwt.2004.02.013

[4]. Baensch W., Yalegama C. & Jayasundera J.M.M.A. (2004).New technologies of coconut processing-part I: process for production of virgin coconut oil and low fat / high proteincoconut flour from coconut kernel, pp. 261–269, *Proceeding II of the International Coconut Conference-2004* (eds.T.S.G. Peiris & C.S. Ranasinghe), Coconut Research Institute of Sri Lanka, Lunuwila.

[5]. Chang S.K.C. (1998). *Food Analysis* (ed. S.S. Nielson). Aspens Publisher Inc., USA.

[6]. Coultate T.P. (2009). *Food: The Chemistry of its Components*. The Royal Society of Chemistry, Cambridge, UK.

[7]. De Man J.M. (1999). *Principles of Food Chemistry*. VanNostrand Reinhold, New York, USA.

[8]. Ediriweera N. & Hashizumi K. (1991). Extractability ofcoconut protein and changes in its gel forming propertieson heating. *Journal of the National Science Council of SriLanka* 19: 115–128.

[9]. Jamaluddin, A., Razak, D.L.A., Rashid, N.Y.A.,Sharifudin, S.A., Kahar, A.Z.M., Saad, A.Z.M. and Long, K. (2016). Effects of solid state fermentation by Monascus purpureus on phenolic content and biological activities of coconut testa andrice bran. Jurnal Teknologi, 78(11/12),pp.23-28.

[10]. Kasseng H.H. (2018). Determination of proximate composition and bioactive compounds of the Abyssinian purple wheat. *Cogent Food and Agriculture* 4(1): 1421415.DOI: https://doi.org/10.1080/23311932.2017.1421415

[11]. K.D.P.P. Gunathilake*, K.V.S.P. Dharmawansa, K.A.U.D. Weerasinghe and A.J.N. Gimasha 2018. Response Surface Optimization for Extraction of Phenolics from Coconut Testa (Pairings) Cord (2018) 34 (2)

[12]. Manisha DebMandal1 , Shyamapada Mandal., Coconut (Cocos nucifera L.: Arecaceae): In health promotion and disease prevention Asian Pacific Journal of Tropical MedicineAsian Pacific Journal of Tropical Medicine (2011)241-247

[13]. Marikkar J. M. N., & Madhrapperuma W. S. (2012). Coconut. Tropical and Subtropical Fruits: Postharvest Physiology, Processing, and Cord 2021, 37 22 Packaging (Ed Muhammed Siddiq). JohnWiley Publishing Co., Ames, Iowa, USA.

[14]. Nur Ain Najwa N.M., Abbasiliasi S., Marikkar J.M.N.,Lamasudin D.U., Shuhaimi M., Arbakariya A., Mehnoursh A. & Yazid A.M.M. (2017). Defatted coconut residue crudepolysaccharides as potential prebiotics on proliferation and acidifying activity of probiotics *in vitro. Journal of FoodScience and Technology* 54: 164–173.

[15]. DOI:https://doi.org/10.1007/s13197-016-2448-9

[16]. Oliveira, M.S., Feddern, V., Kupski, L.,Cipolatti, E. P., Badiale-Furlong, E., and SouzaSoares, L.A. (2011). Changes in Lipid, Fatty Acids and

Phospholipids Composition of Whole Rice Bran After

[17]. Solid-state Fungal Fermentation.Bioresource Technology. 102: 8335-8338.

[18]. Prasad, K.N., Hassan, F.A., Yang, B., Kong,K.W., Ramanan, R.N., Azlan, A., Ismail,A. (2011). Response surface optimisation for the extraction of phenolic compounds and antioxidant capacities of underutilized Mangifera pajang Kosterm peels. Food Chemistry. 128(4):1121-1127.

[19]. Raihana A.R., Marikkar J.M.N., Ismail A. & Musthafa S.(2015). A review on food values of selected fruits' seeds. *International Journal of Food Properties* 18: 2380–2392.DOI: https://doi.org/10.1080/10942912.2014.980946

[20]. S.S.K. Marasinghe1 , J.M. Nazrim Marikkar1*, C. Yalegama2 , S. Wimalasiri3 , G. Seneviratne1 , R. Weerasooriya1 and R Comparison of inter-varietal differences in chemical composition and nutritional properties of coconut testa flour Article *in* Journal of the National Science Foundation of Sri Lanka · July 2019.DOI: 10.4038/jnsfsr.v47i3.8699

[21]. Yalegama L.L.W.C., Karunaratne D.N., Sivakanesan R. &Jayasekara C (2013). Chemical and functional properties of fibre concentrates obtained from by-products of coconut kernel. *Food Chemistry* 141: 124–130.

[22]. Yalegama L.L.W.C. & Chavan J.K. (2006). Studies on utilizationof coconut flour as a source of cell wall polysaccharides. *Tropical Agricultural Research* 18: 126–134.

[23]. Zhang, Y., Zheng, Y., Duan, K. and Gui, Q.(2016). Preparation, antioxidant activity and protective effect of coconut testa oil extraction on oxidative damage to human albumin serum, International Journal of Food Science and Technology 2016, 51,946-953.