Integrated Technology for Producing Eco-friendly Coconut Biofuel through Cost Effective Way

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Despite the nutritional and therapeutic benefits of coconut oil, its use as an effective biofuel by trans-esterification of the oil to coconut methyl ester (CME) has opened a new avenue in the field of coconut oil industry. The technical quality, functional feasibility and the ecofriendly nature of coconut methyl ester (CME) have given a distinct renewable energy status for coconut biofuel compared to other biofuels. The production of CME from coconut oil and its biofuel efficacy directly in diesel vehicle were optimized and confirmed by test run. The low carbon residue, minimal acidity and negligible sulphur element support coconut biofuel as ecofriendly. But the variable cost of the oil and the unstable nature of the quality of the oil available in the market are the serious constraints for the production of CME on industrial scale. Hence an integrated approach of producing CME from de-husked mature coconuts was designed for making the industry cost effective and stable. The implementation of integrated technology for developing CME from mature de-husked coconuts produce four sub products at each level of processing- i). shell, ii). mature coconut water (MCW), iii). oil cake,iv). glycerol. A rapid processing method was standardized for enriching mature coconut water (MCW) with natural nutrients for its conversion to a health drink, similar to tender coconut water. The commercialization of each sub-products derived during the processing of CME production from de-husked coconuts is found as a successful chain for bringing the total cost of the coconut biofuel to a reasonable price considerably less than the cost of petro-diesels. A consortium of all coconut growing countries at global level and the technical support of APCC are inevitable for analyzing the feasibility of this 'new fire' in the midst of the present economic hike of fossil fuels.

Introduction

The crucial factor of determining the growth of a country or a state depends on the detection and effective utilization of the natural resources for the well-being of the society. As a tropical oleaginous crop, the multifaceted properties of coconut at nutritional, therapeutic and industrial level have been well established by several researchers [1,2,3,4]. A protocol for producing coconut methyl ester (CME) and glycerol from coconut oil and its functional efficacy as a biofuel in diesel engines under road trials have been optimized and confirmed [5]. Though the transesterification of coconut oil to coconut biofuel with better fuel efficacy has become a new trend of coconut biofuel research, ambiguity persists in the cost effective production of coconut biofuel for popularizing it under industrial scale. Based on the price variations of the coconut oil at global market, it may not be economically viable to produce coconut biofuel directly from the oil purchased from the market under industrial scale. Moreover, the purity of the coconut oil purchased from open market with respect to the free fatty acid, moisture and other contaminants itself will be a problem for maintaining the quality of the fuel. In the present investigation, an effort was taken to detect the new positives in the production of coconut biofuel initiating from mature de-husked coconuts by an integrated approach

so that the sub products derived at each level of production can be effectively utilized in order to stabilize the fuel quality and to make the production cost effective.

Processing of Dehusked Matured Coconuts

The production of Coconut Methyl ester (CME) from mature de-husked coconuts was undertaken by two major steps.i). Extraction of the oil from matured coconuts ii). Trans-esterification of the oil to Coconut methyl ester (CME). In order to maintain the quality of the coconut oil with consistent level of moisture and FFA for the transesterification process, the extraction of fresh oil from coconuts is inevitable. So the entire production of coconut methyl ester (CME) was started from the de-husked nuts purchased commercially. For the study, mature de-husked nuts were used for the production of CME. The mature coconuts were purchased as per the current market price published by Coconut Development Board, Cochin.Figure1 demonstrates the material balance of 10,000 de-husked nuts processed for the production of coconut oil.

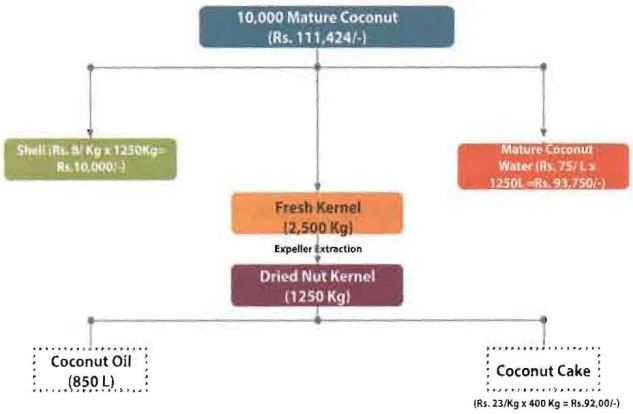

Figure 1. Material balance of 10,000 de-husked nuts processed for the production of coconut oil. The quantity and the approximate market value of each product is given in bracket.

Treatment of Mature coconut water (MCW)

As the first step of the process, the de-husked nuts were de-shelled in an aseptic condition with a mechanical cutter and the mature coconut water was filtered and stored in a sterile vessel containing the anti-fermentation mix. The filtered mature coconut water was further processed for enriching its nutrients by upgrading the quality similar to tender coconut water (TCW). The enriched mature coconut water was pasteurized and bottled as soft drink similar to TCW.The schematic diagram showing the protocol of processing mature coconut water during the processing of de-husked nuts is displayed in figure 2.

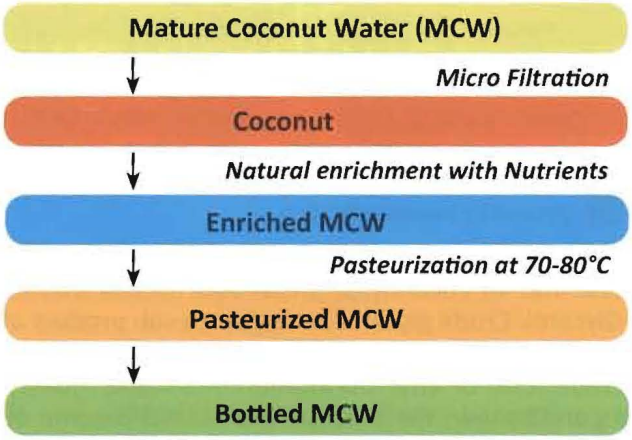

Figure 2. Schematic diagram showing the protocol of processing mature coconut water (MCW) derived as sub product during the processing of de-husked nuts.

Extraction of Coconut oil

The broken nuts with the wet endosperm were kept in hot air chamber for 8 hours for removing the shell from the endosperm. Initially the temperature of the chamber was kept at 90°C for 3 hours for the fast removal of moisture and subsequently the temperature was reduced to 70°C for avoiding the browning of the endosperm. After proper drying, the deshelled dry endosperm (copra) was subjected to the extraction of oil by expeller method. The shell was collected separately as the second sub product of the processing. The quality of the oil was checked by analyzing the parameters like moisture, fatty acid content, saponification value [6,7].The expeller extraction of oil from the dried endosperm provide coconut cake as the third sub product. Commercially coconut oil cake has a great demand in cattle feed industry.

Production of Coconut Methyl Ester (CME)

The extracted oil was used for the trans-esterification process as per the procedure optimized by Mohankumar *et al.*, 2015 [5]. As per the protocol of the esterification of coconut oil,the processing of 10,000 de-husked nuts provide 850 L coconut oil and it can be converted in to 760 L of CME and 80-90 L crude glycerol at the rate of

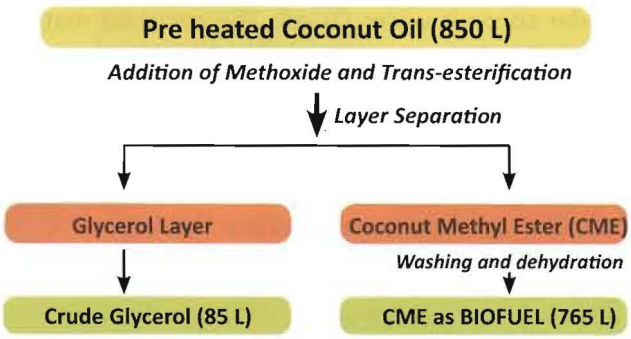

Figure 3.Processing profile of coconut oil to CME and glycerol by transesterification

one liter of coconut oil yields 900 ml and 100 ml Glycerol. Crude glycerol is the fourth sub product of the processing and it can be marketed either in the crude form or after purification in a higher quality. Figure 3 shows the processing profile of coconut oil to CME and glycerol by trans-esterification. For the transesterification process of 850 L oil extracted from the dried endosperm of 10,000 nuts, cost of the catalyst methoxide, electricity, man power and other miscellaneous can be rounded as a total of Rs. 40,000/-.

Market value of the sub products derived during the production of coconut methyl ester (CME)

The evaluation of the sub products with respect to its practical utility on commercial angle has got greater significance. The shell of coconut is actively used for the preparation of natural activated charcoal which is far better than wood and bone charcoal in the industry. Coconut shells are best suited for activated carbon as they have the capacity to withstand the heat during the process of pyrolysis because of the hardness which is 95%. As a nutritive health drink, tender coconut water has a prime position in the natural soft drink industry. During the development of young nut to mature from 6 to 11 months, a gradual physiological depletion of nutrients of tender coconut water (TCW)was occurred during maturation. But this diminishing level of nutrients can be compensated by enriching mature coconut water (MCW) with natural nutrients. Though the nutrient level is decreasing in mature coconut water during development, it still retains the flavor and the aroma of coconut water similar to TCW. So the enrichment of mature coconut water by supplementing nutrients will develop a new stream of development in coconut industry. The fortified mature coconut water (MCW) with enriched nutrients can be marketed as a natural soft drink similar to tender coconut water and coconut Neera. Moreover this will indirectly solve the environmental pollution of spilling mature coconut water during processing in oil industry.The oil cake produced during the expeller extraction of coconut oil and the glycerol formed by chemical transesterification of the oil have developed separate marketing status for both the products, especially coconut glycerol. The shortage of pure vegetable glycerol is one of the major challenges of cosmetic industry today. So the coconut glycerol will be good source for meeting the need.

Coconut Bio- fuel @ Rs.50/-

Besides the eco-friendly nature of coconut bio fuel with negligible level of carbon, moisture,sulphur and other air pollutants, the production of biofuel as cost effective way is essential for popularizing this renewable energy source and it in turn helps the coconut farmers for providing a stable market price for their products. Hence an integrated approach of producing coconut biofuel from de-husked mature nuts by utilizing the sub products derived at each level of processing will make tremendous change in the field of biofuel industry in the country. The systematic way of utilizing the sub products like coconut shell, coconut water, oil cake and glycerol at commercial angle will definitely keep the price of one litre ecofriendly biofuel at a level less than Rs. 50/ without any subsidy from the government. Since the functional feasibility of coconut biofuel has been tested successfully in diesel vehicles, more road trial experiments are warranted to establish the utility of coconut biofuel in new generation vehicles. More extensive research innovations are essential to upgrade the quality of coconut biofuel by revealing its technical specifications for using it as jet fuel. So an immediate attention of national and international agencies for the promotion of coconut is warranted to meet the commercial feasibility of this new renewable energy source which would be a boon to all the coconut growing countries of the world.

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