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RESEARCH PAPER

Production of *Nata de Coco* - a Natural Dietary Fibre Product from Mature Coconut Water using *Gluconacetobacter xylinum* (sju-1)

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Abstract

Nata de coco is a natural dietary fibre food product obtained by static fermentation of any sugar rich substrate using *Gluconacetobacter xylinum*. *Nata* producing microorganism has been isolated from sugarcane juice and was used to produce *nata*. The yield of *nata* was about 250 gL^{-1} in coconut water medium. *G. xylinum* (sju-1) produced more quantity of *nata* with thickness accounting to 13 mm and 15 mm in HS medium and mature coconut water medium, respectively. The water holding capacity, hardness and crude fibre content of *nata* produced from coconut water medium were found to be 87.14%, 41 N and 11.25g respectively. The developed *nata* was formulated successfully in sugar syrup base using natural colorant obtained from beet root pigment. It could be concluded that the mature coconut water can very well be exploited for the development of *nata*-a value added fibre food, using *G. xylinum* (sju-1).

Keywords: *Nata de coco,* static fermentation, *Gluconacetobacter xylinum,* coconut water medium, value added fibre food

A large amount of mature coconut water is discarded during the course of coconut processing. Value addition of this nutritious liquid waste for the production of *nata* by static fermentation is considered beneficial not only for reducing pollution problem but also producing a natural dietary fibre. Bacterial cellulose produced by *Gluconacetobacter xylinum* (formerly *Acetobacter xylinum*) at the air-liquid interface of coconut water is popularly known as *nata*-de-coco. *Nata* derived from Latin word *natare* which means "to float" from fermenting coconut water or fermenting rotting fruits. *Nata* can grow in coconut milk, an abundant domestic waste product or in a nutrient medium. It is a white, gelatinous food product popular in Philippines, Japan and Malaysia (Kongruang, 2008). Being microbial cellulose, it is highly hydrophilic, holding water over 100 times its weight. The water trapped in the cellulose matrix is highly useful for its application in food industry as a jelly like food. It has a distinct textural properties like a firm chewy, soft and smooth surface and is rich in fibre. Apart from *nata*, many potentially high value markets exist for thin film bacterial cellulose, including acoustic diaphragms, artificial skin, pulp and paper industry artificial blood vessels, liquid loaded medical pads, super-sorbers and specialty membranes. The production of *nata* is receiving a great attention because of its wide application possibilities (Keshk and Sameshima, 2006).

Nata is relatively expensive to produce and as such is unlikely to replace traditional sources of cellulose. Medium costs limit commercial use of *nata*. So use of alternative substrates is one way to reduce the cost of producing *nata*. Coconut water is a tasty and

refreshing drink, very popular in Brazil and other tropical countries. It consists primarily of sugars, minerals, protein nitrogen and vitamins but is slightly acidic, with pH around 5.5, transparent, non-sticky and slightly sweet taste. These features make the coconut water an excellent substrate for microbial growth.

Hence a study was undertaken at the Department of Agricultural Microbiology, Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamilnadu, India to develop *nata* from mature coconut water using *G. xylinum* and the results are discussed in this communication.

Materials and Methods

Microorganism and culture conditions

Strain of *G. xylinum* was isolated from sugarcane juice in the Department of Agricultural Microbiology, TNAU, Coimbatore, Tamilnadu, India. The organism was grown and maintained on nutrient agar and stored at 4°C. *G. xylinum* cells were grown in nutrient broth for 24 h at 30°C and were harvested by centrifugation. The sedimented cells were washed three times in a 0.1% peptone solution, resuspended to the desired count and used immediately in the experiments.

Substrate Preparation

Mature coconut water was collected in a cleaned containers from university hostel and canteen. It was filtered using a muslin cloth. Then, to 1.0 L of coconut water 10 g of sucrose and 5 g of yeast extract was added and sterilised for 20 min at 20 psi in an autoclave, cooled and placed in container (21 × 27 × 8 cm) and then, covered with clean paper. pH value was adjusted to 5.5 with the addition of acetic acid. Hestrin Schramn (HS) medium which is routinely used for the cultivation of *G. xylinum* was prepared and sterilised as prescribed (Hestrin and Schramn, 1954).

Static Fermentation

The sterilised substrate was then, inoculated with starter of *G. xylinum* containing $2.0x10^7$ cell/ ml under aseptic condition. Then, the entire set up was incubated at static condition in an incubator at 30°C for 14 days. Similarly, the culture was inoculated into the HS medium to compare the production efficiency.

Harvesting

The *nata de coco* produced was harvested by filtration and it was washed well in a running tap water to eliminate the sour taste, and then, cut into small cubes for further processing to make *nata* in a syrup base.

Preparation of syrup based *nata de coco*

The *nata* cubes were boiled for 15 min to remove the acid flavour completely and to kill the bacteria, if any. The water was drained completely from the cubes and soaked in sugar syrup at 72°Brix. Then, to it dark red colour pigment was added which was obtained from beet root extract developed from post-harvest technology centre, TNAU, Coimbatore and boiled for 5 min. It was then cooled and vanilla flavour was added to it. The product was then stored in a sterilised containers at room temperature.

Physical and biochemical characteristics of *nata de coco*

Physical and biochemical characteristics such as wet weight, moisture, pH, thickness, texture (hardness), water holding capacity (WHC), crude fibre, potassium, sodium and iron content were analysed. The fresh *nata* formed was lifted and after several washing, the excess water was dripped-off completely and weighed for measuring the wet weight (g). The moisture content (%) was determined based on the weight loss of the cut cubes when dried under vacuum for 8 h at 25 bar pressure at 75°C. A known quantity of *nata* was homogenised using a homogenizer at 10000 rpm and the pH was analyzed using a digital pH meter. The thickness (mm) was measured using a digital calliper. *Nata* after cutting into perfect cubes of equal dimensions

was wrapped in filter paper and centrifuged at 5000g for 10 min. During centrifugation the water released was absorbed by the filter paper. The per cent ratio of the moisture in the centrifuged *nata* to the original moisture content yielded the WHC of the *nata* (Bourne, 2002). The hardness of the *nata* was analysed using a texture analyser (TA-XT2 Stable Microsystem, Surrey, UK). *Nata* sized 7.5x7.5x1.0 cm were used after incubation in a hot oven at 100˚C for 3 h. The instrument was set as follows: 4.0 cm distance between probe and samples, 1.0 mm/s pretest speed, 1.0 mm/s test speed, and 10.0 mm/s post test speed. The compression test was run at a rate of 20 times per sample. The compression force was recorded as prescribed by Bielecki *et al*. (2005). Crude fibre, potassium, sodium and iron were analyzed (AOAC 2002).

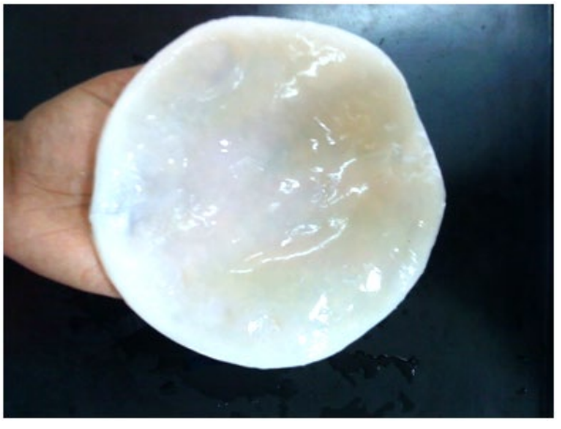

Fig. 1. Fresh *nata* formed from mature coconut water using G. xylinum(sju-1)

Fig. 2. Diced, beet root extract coloured *nata*

Results and Discussion

A thick layer of *nata* was formed on the surface of the HS medium and coconut water medium by *G. xylinum* (sju-1). The productivity of *nata* was about 250 gL^{-1} when mature coconut water was used as the substrate, whereas in HS medium it was180 gL^{-1} (Table 1). The biosynthetic yield is comparatively higher in the coconut water substrate than the HS medium.

The washed, boiled cellulose pellicle obtained from mature coconut water medium and diced beet root extract coloured *nata* is depicted in Fig. 1 and 2. *G. xylinum* (sju-1) produced more quantity of *nata* with thickness accounting to 13 mm and 15 mm in HS medium and mature coconut water medium, respectively. Earlier reports of *nata* production by *G. xylinum* NCIM 2526 using tender coconut water was found to produce 9.5mm thickness of *nata* (Jagannath *et al*. 2008). Glucose, sucrose, fructose are the most preferred carbon sources for *nata* production. Since coconut water is rich in all of these sugars, major and minor nutrients have greatly influenced the production of *nata*.

The moisture content of the *nata* produced was 92.27% and 92.90% in HS and mature coconut water medium. pH of the fermenting medium decreased in both the HS and coconut water medium. Coban and Biyik (2011) has indicated that *nata* and acid production are negatively correlated. If gluconic acid production is greater the yield of *nata* is reduced. The Water Holding Capacity (WHC) of *nata* from coconut water medium was 87.14% which reflects its highly juicy nature in comparison to the *nata* produced from HS medium and mode it highly suitable for food purposes, especially in salads (Bielecki *et al*. 2005) The hardness of *nata* was recorded to be 43 N and 41 N in HS medium and coconut water medium, respectively. Lynd *et al*. (2002) have also established that the micro-fibril cellulose is more delicate, softer and superior than other types of fibre found in fruits and vegetables. Hermansson (1986) has proved that bacterial cellulose has got unique texture and structure when grown in sugary rich medium and could hold water over hundreds of times of its weight.

Table 1. Physicochemical Characteristics of *nata de coco*

Physicochemical characteristics	HS medium	Mature coconut water medium
Wet weight of cellulose(g/L)	180.00 ±0.82	250.00 ±0.21
Moisture (%)	92.27 ±2.10	92.90 ±3.12
pH (final)	4.00 ±0.16	4.50 ±0.07
Thickness (mm)	13.00 ±0.14	15.00 ±0.01
Hardness (N)	43 ±2.0	41 ±3.0
Water Holding Capacity (%)	84.44 ±1.11	87.14 ±1.13
Crude fibre (g)	10.74 ±0.22	11.25 ±0.04
Sodium (mg)	45.00 ± 0.08	41.00 ±0.09
Potassium (mg)	245.00 ±1.50	241.50 ±0.02
Iron (mg)	0.08 ±0.01	0.07 ±0.01

Mean ± Standard Deviation

The crude fibre content was in the range of 10.74 g and 11.25 g. Fibre content of *nata* clearly elucidates that the cellulose provides a good fibre rich product. Santosa *et al*. (2012) has also indicated that the crude fibre content of *nata de coco* developed by mixing coconut water medium with dextrin and Carboxy Methyl Cellulose (CMC) was found to be 38.2%. Halib *et al*. (2012) proved that *nata de coco* was found to be soluble in cupriethylenediamine, a well known solvent for cellulose and confirmed that to be a good source of dietary fibre. The results of the present study are also in conformity with that reposted earlier. According to Mesomya *et al*. (2006) *nata-de-coco* with crude fibre of 9.20 g was an organic dietary food supplement used to control serum triglycerides in hyperlipidimic patients.

Conclusion

Nata de coco prepared using mature coconut water could serve as a healthy dietary fibre food. It can be used in desserts, ice cream and as salad dressings. *G. xylinum* (sju-1) strain isolated from fermented sugarcane juice produced more quantities of *nata* than the earlier strains. *Nata* has got a high market potential in South East Asian countries.

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