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Studies on development of neera powder from coconut (*Cocos nucifera* L.) neera by using spray dryer

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Abstract
Coconut sap (Neera) has natural source of proteins, vitamins minerals, and rich amount of sugar which is collected from coconut palm, but auto fermentation is a major drawback in coconut neera, spray drying is a tool to reduce the fermentation process. Coconut neera powder was developed through spray drying at different inlet air temperature (130 °C, 140 °C, and 150 °C) and TSS at 20° brix, 25° brix, 30° brix and feed rate of 25ml/min. Physical properties of coconut neera powder were investigated and mini spray drier was used. Study results indicated that the inlet air temperature of 130 °C and with the addition of carrier agent (Maltodextrin) 25° brix produces the maximum drying characters.

Keywords: coconut neera, physical properties, maltodextrin, spray drying, coconut neera powder

Introduction
Coconut (*Cocos nucifera*) is a famous and important palm, member of the palm family (Arecaceae). All the parts of palm such as edible kernel, fiber, trunk, leaves, frond, coconut water, coconut inflorescence sap were used for human life so it is known as 'kalpavriksha' (tree of heaven). India is the major country in coconut production and productivity in the world. Total cultivation area of 1975.81 hectares and production of 21,665 million nuts amounts in annual GDP rate of 15,000 crores in INR. Some of the major coconut producing countries are Indonesia, Philippines and India. In India, major coconut producing states are Tamil Nadu, Kerala, Odisha, West Bengal, Karnataka, Maharashtra and Pondicherry. India ranks first in productivity among all the countries. In Tamilnadu major coconut producing districts are Tiruppur and Thanjavur. In productivity Krishnagiri and Theni ranks first in Tamilnadu (Raghavi *et al.*, 2019) [15].

Major products developed from coconut are coconut neera, honey, jaggery, palm syrup and coconut sugar. Among them coconut inflorescence sap (Neera) has many health benefits; it helps in the digestion, clear urination and also has best medicinal value for jaundice. It is a good source of potassium which can be used against anemia to improve the iron level in the human body and also helps in curing the lower blood pressure. Neera contains less sugar content (14-18%), with low Glycemic Index (GI of only 35), hence it is beneficial for diabetic patients. This also have antibacterial, antifungal, antiviral, antioxidant and anticancerous properties (Misra, 2016) [12].

Freshly tapped unfermented coconut sap contains 15-18% (w/v) of sucrose. It is reported that fermentation occurs within the hours, so addition of anti fermentation compounds in coconut inflorescence sap will results in delaying of fermentation process until 14 to 15 hours (Atputharajah, *et al.*, 1980) [3]. Recently, spray drying is one of the methods to maintain the nutritional quality of neera with 0% alcohol at the same time it will increase the shelf life. Spray drying is the best method for conversion of liquid to powder (Adhikari *et al.*, 2009, Jayasundera *et al.*, 2011) [1, 9]. So spray drying is an option to produce the unfermented neera powder, which can be preserved for prolonged periods.

Coconut neera is easily available in rural area but not reachable to the urban area due to the natural fermentation, so spray drying process is implemented to reduce the water activity in neera and made into powdered form. This powder should make available in urban areas so that people can consume this energy drink. Hence this research was undertaken with the objective to standardize the production of neera powder with optimal drying temperature for spray drying.

Materials and methods

Collection of coconut inflorescence sap (Neera)

Coconut sap (Neera) was collected from the farmer's field from Coimbatore and stored in icebox and is spray dried on same day.

Preparation of feed solution

Maltodextrin was purchased from local market. Unfermented coconut inflorescence sap was taken and the TSS was adjusted by adding maltodextrin at different concentration's *viz.*, 20º brix, 25º brix, 30º brix and different inlet air temperature levels (130 °C, 140 °C, and 150 °C) were used for drying.

Spray drying process

The spray drying procedure was followed as reported by Pandidurai and Vennila (2018) [14]. The parameters such as total soluble solids (TSS), inlet air drying temperature, outlet air temperature and feed rate of coconut inflorescence sap were standardized for the preparation of neera powder (Table 1). After setting the parameter, coconut neera was fed into drying chamber and developed powder was collected and packed. The flowchart for development of coconut neera powder using spray drier was shown in Fig-1.

Table 1: Parameters for the production of coconut neera powder in spray drying process

Parameters	Levels
Total soluble solids (TSS)	20, 25, and 30ºbrix
Inlet air temperature	130, 140 and 150ºC
Outlet air temperature	50 ºC
Feed rate	25 ml/ min

Physical properties of spray dried neera powder such as powder recovery, moisture content (Ranganna *et al.*, 1995) [16], water solubility (Schoch, 1964) [17], bulk and tapped density (Chegini and Ghobadian, 2005) [6], flowability (Tze *et al*., 2012) [20] carr index (Carr, 1965) [5], hausner ratio (Hayes *et al*., 1987) [7], hygroscopicity (Cai and Corke, 2000) [4] were analyzed.

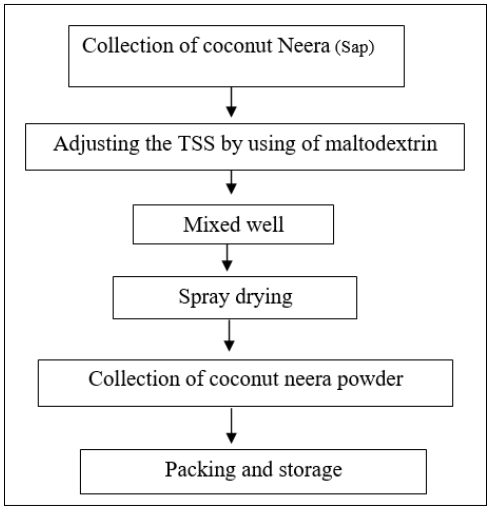

Fig 1: Production of coconut neera powder

Result and discussion

Table 2: Physical properties of Coconut neera powder

Parametres	20 ° bx			25º bx			30º bx		
	130°C	140 °C	s150 °C	130 °C	140 °C	150 °C	130 °C	140 °C	150 °C
Powder recovery per lit of neera (g)	130	145	156	198	192	184	194	196	160
Moisture content (%)	3.00	2.35	2.08	2.81	2.24	1.95	2.68	2.15	1.75
Water activity (aw)	0.29	0.25	0.23	0.28	0.22	0.19	0.27	0.20	0.17
Water solubility (%)	98.80	98.85	98.70	99.87	98.90	74.81	98.95	99.00	70.23
Hygroscopicity (%)	10.78	12.92	14.07	12.57	13.15	14.35	12.86	13.67	14.73
Bulk density (g/cm^3)	0.68	0.65	0.61	0.69	0.66	0.62	0.71	0.70	0.64
Tapped density (g/cm^3)	0.72	0.71	0.70	0.74	0.73	0.71	0.78	0.77	0.76
Hausner's ratio	1.05	1.09	1.14	1.07	1.10	1.15	1.09	1.10	1.18
Carr index (%)	5.50	8.45	12.80	6.75	9.50	12.60	8.90	9.00	15.70
Flowability	Excellent	Excellent	Good	Excellent	Excellent	Good	Excellent	Excellent	Good

Production of spray dried coconut neera powder at different temperatures

The Physical properties of spray dried coconut neera powder was carried out and the results of the same are presented in the Table 2.

The coconut inflorescence sap (neera) with 25°brix TSS and spray dried at 130 °C inlet air temperature had the highest powder recovery of 198g/lit. The powder yield was lower when total soluble solids (25 and 30ºbrix) are high and higher drying temperature (140 °C and 150 °C), as it create paste on drying wall due to more deposition of solids (Table 2).

As the spray dryer produces fine powder through atomization, it creates small droplets in drying chamber with hot air where droplets dry quickly. Maltodextrin helps in lesser deposition of powder in the chamber wall and also it creates hygroscopic and hydrophobic balance to reduce the stickiness problem in the preparation of neera powder (Nurhadi *et al.*, 2018) [13].

Moisture content of powder was decreased from 3% to 1.75% when inlet air temperatures (130 °C, 140 °C, 150 °C) and Maltodextrin concentrations (20, 25, and 30ºbrix) were increased respectively.

Inlet air temperature of spray dryer chamber ranges between 120 °C to 200 °C in gac powder. As the inlet air temperature increases the moisture content of the powder gets decreased (5.29% to 3.88%) (Tuyen *et al.*, 2010) [19].

The Water activity of spray dried powder also exhibited the same decreasing trend from 0.29 to 0.17 aw when inlet temperature was increased at different concentrations of Total soluble solids (130 ºC inlet air temperature and 20º brix to150 ºC inlet air temperature and 30°brix) as shown in Table 2. As confirmed by the study done by Jayasundera and Kulatunga (2014) [8] suggested that spray dried coconut treacle powder stored on ambient temperature (30±2 ºC) for period of one year increased the shelf life of spray dried products. This mainly depends on water activity (aw) and it should be less than 0.6 aw which is microbiologically stable in food system as reported by Kanpairo *et al*., 2012 [10].

The highest water solubility (99.87%) was observed in 130 °C inlet air temperature and 25° brix of Maltodextrin (Table 2).

Addition of Maltodextrin in feed solution will reduce the moisture content and hygroscopicity of spray dried powder and also creates more glass transmission temperature (T_g), bulk density and solubility (Kingwatee *et al*., 2015) [11].

Hygroscopicity of spray dried coconut neera powder ranged from 10.78% to 14.07%, 12.57% to 14.35% and 12.86% to 14.73% in 20° brix, 25° brix and 30° brix respectively. Carrier agent and temperature directly affects the hygroscopicity of spray dried powder. As there is an increase in the TSS and decrease in the temperature, it produces the lower level of hygroscopicity (Table 2).

Shittu and Lawal (2007) [18] reported that addition of maltodextrin in feed solution increases the flowability of powder and reduces the stickiness problem due to low molecular sugars (Glucose, sucrose, fructose and organic acids). High sugar content of feed solution absorbs the moisture, increases the Maltodextrin concentration and also reduces the moisture absorption and hygroscopicity.

From the results it indicates that bulk density and tapped density ranges between 0.61 to 0.71g/cm^3 and 0.70 to 0.78 g/cm^3 among the different treatment as shown in Table 2. An increase in the inlet air temperature at different concentration of Total soluble solids automatically reduces the bulk density.

Sun *et al.* (2016) [2] reported that increasing maltodextrin concentration in feed solution increases the bulk density of spray dried coconut sugar. They also reported that stickiness was the main problem in spray drying but this can be reduced by increased concentration of maltodextrin.

Flowability of neera powder was observed and the excellent flowability was noticed at 130 °C and 140 °C inlet air temperature but whereas good flowability of powder was observed in 150 °C. Flowability of powder was based on measurement of Hauser's ratio (1.05-1.18) and Carr index which ranges from 5.50-15.70% (130 ºC inlet air temperature and 20ºbrix to150 ºC inlet air temperature and 30°brix) as shown in Table 2.

This indicated that excellent flowability of powder in inlet air temperature is achieved between 170 °C to 180 °C and good flowability of powder is achieved at 190 °C inlet air temperature in muskmelon fruit pulp powder (Pandidurai and Venila, 2018) [14].

Conclusion

Coconut neera powder was produced through spray drying with the help of carrier agent (20, 25, and 30ºbrix), and inlet air temperature (130, 140 and 150 ºC). Excellent flowability of powder was observed between the ranges of inlet air temperature 130 °C and 140 °C. Increased level of inlet air temperature and Maltodextrin could produce the higher hygroscopicity. Water solubility (99.87%) was higher at 130 °C inlet air temperature and 25°brix. Increased concentration of Maltodextrin (25°brix) recorded higher powder yield (198g/lit). Maximum drying characters were found at 130 °C inlet air temperature and 25° brix to produce better quality of coconut neera power.

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