

An Update on Uses, Benefits and Potential Application of Neera

Anjali Sharma ¹ and Murlidhar Meghwal ^{2*}

¹IGNOU Study Centre NIFTEM Kundli, Sonapat, IGNOU Regional Centre Karnal, Haryana, India

²Department of Food Science and Technology National Institute of Food Technology Entrepreneurship & Management, HSIIDC Industrial Estate Kundli - 131028, Sonapat, Haryana, India.

***Corresponding Author:** Murlidhar Meghwal, Department of Food Science and Technology National Institute of Food Technology Entrepreneurship & Management Plot No 97, Sector 56, HSIIDC Industrial Estate Kundli - 131028, Sonapat, Haryana, India.

Received date: October 30, 2021; **Accepted date:** November 22, 2021; **Published date:** December 07, 2021

Citation: Anjali Sharma and Murlidhar Meghwal (2021). An update on uses, benefits and potential application of Neera. *J. Nutrition and Food Processing*, 4(8); DOI:10.31579/2637-8914/072

Copyright: © 2021 Murlidhar Meghwal, This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

Neera is fresh sap obtained from mature inflorescence of palm tree and it is full of essential nutrients. Neera has innate natural fermentation tendency that is why it should be consumed fresh for maximum benefits. It has low glycemic index which makes this drink healthy option for diabetic patient. It helps in scavenging free radicals from body which leads to delaying in aging. The purpose of this study was to examine nutritional content, medicinal utilization, functional properties and various applications of neera. It contains 17 amino acids which are the building blocks of protein and immune system. Neera's by product also very nutritious like palm syrup, palm jaggery, chocolates, candies, sweets, and vinegar. Along with their sweet taste these products are diabetic friendly. It is low in calories and has low pH. It helps in maintaining blood sugar. Apart of being sweet and nutritious it has low calorific value which helps in weight loss. If neera is commercialised in proper way it could be a best substitute in comparison with aerated drink. It is full of vitamins, minerals, amino acids. Its shelf life can be increased by filtration, pasteurization and by addition of preservatives.

Keywords: neera; palm sap; health; fermentation; toddy; medicinal; probiotics; disease: India

Introduction

Fresh Neera is obtained from the inflorescence of palm tree. It is very nutritious and sweet in taste. Fresh neera does not contain alcohol. Along with its delicious taste it is very healthy. There are 12 varieties of palm trees from which have been obtained. Scientific and common name of some palm tree varieties are *Phoenix (sylvestris wild date)*, *Hyphaene spp (dour)*, *Nypafruticans (nipa)*, *Cocos nucifera (coconut)*, *Phoenix*

sylvestristhakil (sugar date palm), *Nypafruticans (monotypic) golpata*, [19]. In India coconut palm sap is called as neera. Palm juice is the juice extracted by tapping the unopened spadix of the palm tree. When the juice is extracted from palm tree it is called coconut sap or 'neera' [8]. Toddy has pH of 3.6 and alcohol contents of 3.3 - 4.0%, depending on the stage of fermentation [27]. As (Figure 1) depicts world major neera producing countries.

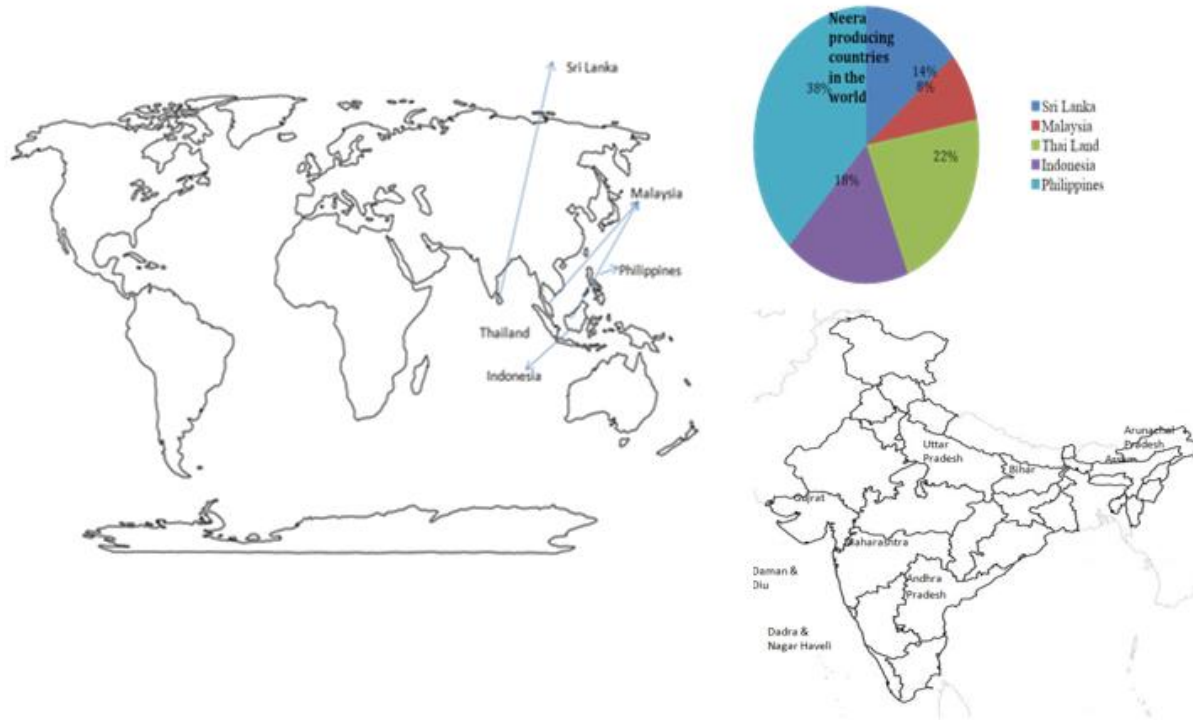


Figure 1: Major neera producing regions in Indian and worldwide

Fresh neera is rich in carbohydrates, vitamins, ethanol, volatile acids, phenolic compounds, and minerals (micro and micro minerals). It contains 16 kinds of amino acids and is also a good source of natural sugar (Table 1).

Sr no	Components	Range
1.	Total solids (g/100 mL)	15.2 – 19.7
2.	pH	7.0 - 7.4
3.	Total sugars (g/100 mL)	10.8 – 14.50
4.	Total reducing sugar (g/100 mL)	0.439-0.647
5.	Ash (g/100 mL)	0.11-0.41
6.	Ascorbic acid (g/100 mL)	0.016 – 0.030
7.	Carbohydrate (g/100 g)	15.000
8.	Proteins (g/100g)	0.23-0.32
9.	Phenolics (mg)	4.80-5.40
10.	Antioxidant activity(mMTE)	0.299-0.355

Table 1: Proximate composition of neera

In this drink, water soluble vitamins are present i.e. Vitamin B complex and C with low calories. It is very good for the digestive system [3,31]. Neera has neutral pH. Palm sugar is traditionally consumed in South and Southeast Asian cuisine, e.g., Indonesia, Philippines and India.

Neera is collected into a sterilized container and an Anti-Fermentation Solution (AFS) is added into the container to prevent fermentation of fresh sap. Neera has innate auto fermentation property due to presence of sugar, microorganism like yeast, bacteria microbial and enzymatic

reaction takes place which leads to production of ethyl alcohol [11]. This is the reason it is highly susceptible to fermentation. It is also temperature sensitive because of the presence of ascorbic acid in it. Under sunlight rapid fermentation occurs which leads to conversion of sweet neera into toddy, within a few hours of extraction from palms. In other words fermented neera is also called toddy which initially contains 4% alcohol and along with times its alcoholic content increases [8]. Palm wine, also known as toddy, is an alcoholic beverage obtained from the sap of various species of palm trees such as the Palmyra palm. There are identified 5

odorants as the major contributors to the toddy aroma. These compounds included 3-isobutyl-2-methoxypyrazine, acetoin, 3-methylbutyl acetate, ethylhexanoate, and 2-acetyl-1-pyrroline [27]. Neera is collected under very hygienic conditions to prevent entry of any foreign particle. The probiotics are basically live organisms that have enormous health benefits on the host when consumed in adequate quantities by keeping our gut healthy and maintaining microbial balance in the system [38]. Also lactic acid bacteria (LAB) isolated from fermented neera, it got naturally fermented and lactic acid bacteria (LAB) are major protagonists [13]. Toddy contains heavy suspension of yeast and bacteria. LAB isolates

which are obtained from neera possess potential probiotic properties [10]. Fermented beverage which is obtained from palm juice has the potential to be used as biofuel (Joseph et al., 2014). Neera nutritional value varies with proper place, time and duration. Probiotics are widely used in infections, especially in the vaginal tract and gastrointestinal infections. They are capable in prohibiting the growth of pathogenic organisms through different mechanisms such as adherence to epithelial cells, anticancer activity, toxin-reducing effects, and boosting immune response, and secretion of antimicrobial compound [38] (Figure 2).

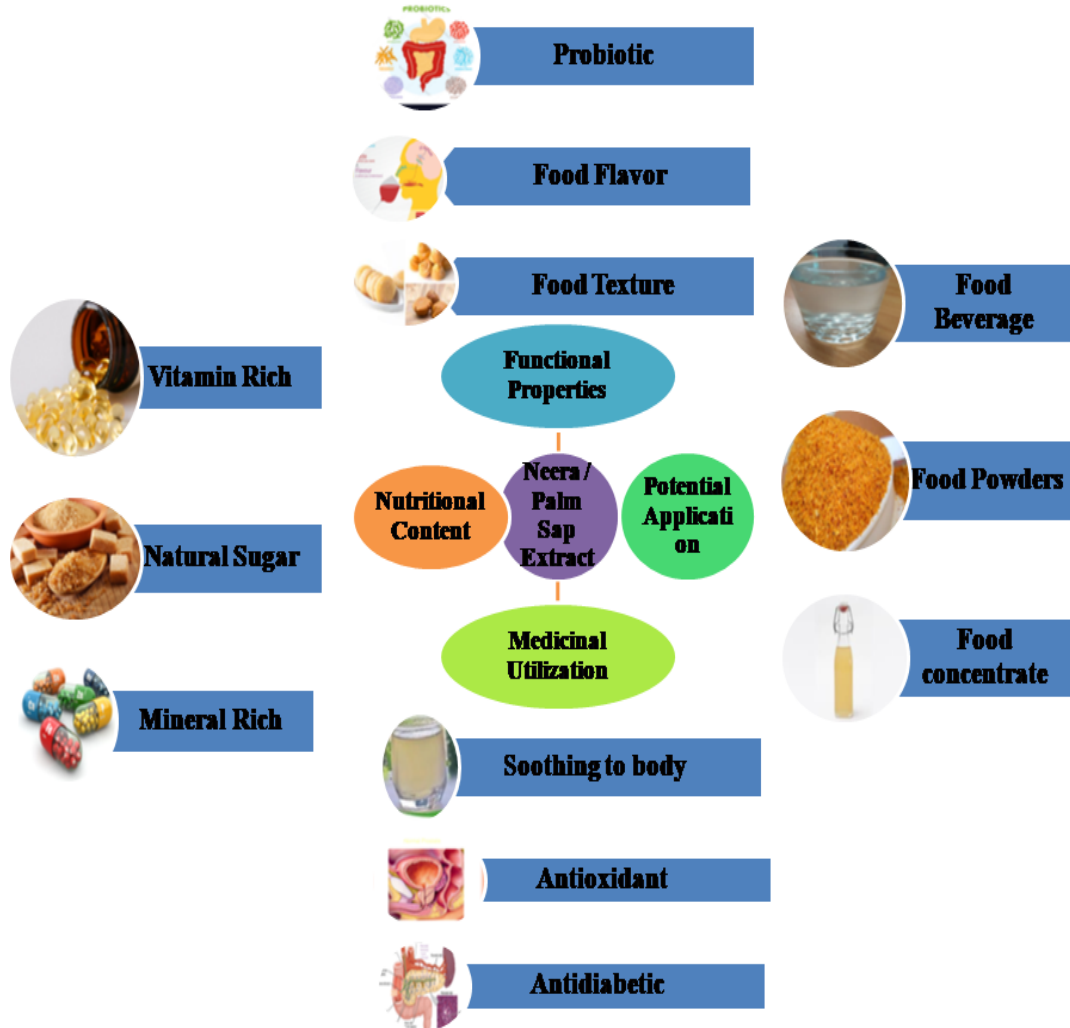


Figure 2: Over all view of neera and neera based products for application and utilities

LAB can efficiently inhibit the growth of pathogenic organisms, decreasing their toxin secretions and increasing the nutritional value [38]. It also acts as a bio-preservative of food and can be used as starter culture in the fermentation process under controlled conditions (Pineiro and Stanton, 2007). Here, the purpose of this study was to examine nutritional content, medicinal utilization, functional properties and various applications of neera.

Source of Neera

Figure 2 depicts Indian major neera producing region and the world major neera producing countries. Neera is widely consumed in India, Sri Lanka, Africa, Malaysia, Indonesia, Thailand, and Myanmar. In India, Maharashtra, Gujarat, Goa, Daman and Diu, Dadra, Nagar Haveli, Tamil

Nadu, Uttar Pradesh, Bihar, Andhra Pradesh, Arunachal Pradesh and Assam are the major neera producing states. On an average one inflorescence per month produced by each coconut palm tree [12,32]. Neera obtained from so many different varieties of palm trees but the actual source of neera is Palmyra palm tree [14]. It takes 15 to 30 years to bear fruit because the growth of palm trees is very slow. They are dioecious (male and female flowers on separate plants). Fibrous pulp is white in colour, sweet in taste and aromatic. The young seedling extends downwards into the soil at the time of germination only a few leaves are visible above ground. However, toddy is obtained by both trees. The black timber is widely used to make wharves, fences and boats because it is very hard, heavy, and durable and highly valued for construction.

Varieties, speciality and cultivation suitability of neera plant (The fruits of neera)

Elaeis Guineensis is a species of palm commonly called oil palm, Palm oil is obtained from palm fruit (*Elaeis Guineensis*). Figure: 3 shows Palmyra palm tree, Female tree, showing foliage crown with fruit. The fleshy mesocarp produces palm oil, which is used mainly for its edible properties and the kernel produces palm kernel oil, which has wide application in the oleochemical industry. It is the major source of palm oil (Sundram et al., 2003).

Palm Oil and its properties

Palm oil is rich in palmitic-oleic rich semi solid fat, some fat-soluble minor components, high oleic acid content, vitamin E (30% tocopherols, 70% tocotrienols), carotenoids and phytosterols. Tocopherols and

tocotrienols are fat-soluble vitamin E isomers and the major antioxidants of vegetable oils. Water-soluble antioxidants, high content of phenolic acids and flavonoids found. Tocopherols can interrupt lipid oxidation by inhibiting hydroperoxide formation in the chain-propagation step, or the decomposition process by inhibiting aldehyde formation. Besides its free radical scavenging activity, tocopherol is highly reactive towards singlet oxygen and protects the oil against photosensitized oxidation. Palm oil from unripe fruits contains more chlorophyll and less carotenoids than oil from mature or ripe fruits. The pigments in palm oil are involved in the mechanisms of autoxidation, photo oxidation and anti-oxidation within the plant. It contains 0% trans-fat. Palm oil is rich in carotenoid. It has numerous health benefits like helps in lowering of cholesterol, anticancer property, delays aging, protects against atherosclerosis [10]. Palm fruit is wholesome nutrient dense superfood (Sundram et al., 2003) (Table 2, Figure 3).

Specific Characteristics	Range min to max
Unsaponifiable matter, % by weight	0.19 to 0.44
Refractive index, Nd 50°C	1.4521 to 1.4541
Saponification value, mg KOH g ⁻¹ oil	194 to 205
Apparent density, g ml ⁻¹ at 50°C	0.8889 to 0.8896

Table 2: Characteristics for crude palm oil



Figure 3: Neera plant and palm fruit

Neera collection method

Palm sap is collected from palm trees. First step is selection of matured unopened inflorescence of the palm. Head of the unopened inflorescence is being cut. The mature inflorescence is tapped. Swelling at the base of the inflorescence is considered the most suitable stage for tapping. The selected inflorescence is uniformly beaten up by traditional method (by palm, hammer) two times in a day (morning and evening) at least for 7 days to stimulate flow of the sap in spadix. The selected matured

unopened inflorescence firstly tied up with strong coir or plastic rope to create pressure to prevent it from bursting. After that 7–10 cm front portion of inflorescence or spadix is sliced off by the sharp sickle. Traditionally taped inflorescence is being inserted into an earthen pot or any sterilize container by greasing inner surface by lemon juice to prevent microbial activity and fermentation only to a certain limit. Drop by drop fresh sap oozes off from the inflorescence. The freshly extracted sap is oyster white in colour [19,26]. (Table 3)

Conventional Method of Tapping	Tapping using Automatic Neera Harvesting System
After cutting inflorescence neera is collected into a sterilized pot	Single time for the initial installation of the device reduces 270 times of tree climbing or men power
Tapper climb at least twice everyday morning and evening up to min 3 months	Tapper sliced off spadix, stimulating flow of neera and collection
Morning: Cutting+Neera collection	Neera is collected from multiple trees
Afternoon: Cutting+beating of spadix	Through network tubing centralized collection

Table 3: Comparison of conventional and automatic method of tapping

Surface sterilization: To squeeze out neera out of spadix palm crown is cleaned properly to expose the surface of the spadix for the smooth tapping. Very first step of neera harvest is to disinfect crown surface or sliced off surface to avoid any aseptic condition. A mild disinfectant-0.05% sodium hypochlorite is being sprayed to create aseptic condition.

Cleaning of spadix surface: The selected spadix for tapping is being sprayed or washed with distilled water from the base to the top for cleaning. By tissue paper washed surface is being wiped to make it dry.

Uniform beating of spadix: The cleaned spadix is being directed to an initial beating process from the base to the top by the trained tappers for 3-4 days. After done with initial beating, the tip of the spadix is being sliced off with the help of sterile knife. Beating process is being continued for at least 10-15 days. Every day the sliced off portion of the spadix is being covered by a sterilized plastic mesh carefully immediately after the beating. This is being done to prevent the entry of any insect and other small organisms. The beating is done twice in morning and evening.

Application of the sterilized clay on the surface of the spadix

The exposed end of the spadix always appeared wet due to the sipping out of neera from the spadix during the beating process. Also there is possibility of leaching of this sugary sap to the basal part of the spadix which can damage the entire system [40]. To prevent this damage a sticky matrix is being spread on the surface of the sliced off end or exposed end. Traditionally tappers used sticky natural clay on the exposed surface. To prevent any kind of damage to the neera drink slight modifications are being made like- sterilization of clay, sterilized clay is applied on the exposed end of the spadix by the tapper. The tapper wear gloves while applying the clay on the exposed surface to prevent any other contamination. By autoclaving clay can be sterilized.

Collection vessel

Earthen pot or clay pot is used for neera collection by the tappers. One common or very general limitation with earthen pot is that due to the repeated use of the same pot by the tappers for neera collection, it is not properly maintained in hygienic way. In the case of neera harvesting, to adopt aseptic mode sterilized plastic vessel of 5 L capacity is commonly used. The plastic vessel is cleaned and sterilized prior to the processed spadix for collecting neera.

Insertion of sterile vessel to the exposed surface of the spadix

After 15-20 days of regular beating of the spadix the vessel is inserted to the exposed end of the spadix from which neera is sipping out. Main reason behind continuous beating is to create pressure inside spadix due

to which neera sipping out of the spadix. Neera exudated from the processed spadix at a rate of 100-200 mL in 3 to 4 hours initially and volume increased to 1L along with time after 1 month and subsequently to 2 L after two months. Neera exudate varies from palm to palm based on several factors-age, height, health of the palm and time of collection.

Collection of neera

The vessel generally kept for collection two times a day- morning and evening under the same spadix. The collection vessel kept in the morning can be harvested in the evening, and the vessel kept in the evening can be harvested by the next day's morning. On an average yield of 2 L/palm sap/day can be harvested, majorly depending on the age and health of the palms, the volume will increase to 3-5 L/palm/day. By using a refractometer, the Brix value (dissolved solid in the liquid) of the harvested Neera is being checked.

Protein degradation kinetics of neera due to yeast

Fresh sap is a rich source of asparagine and glutamine. It is a very rich source of amino acids. Amino acids are the building block of protein. It contains in total 17 amino acids which helps in maintaining proper acid/alkaline balance (neutral pH) [34]. Fresh neera contains approx. 2.6 g kg⁻¹ content of amino acids. Due to presence of yeast in neera autolysis of yeast occurs. Which leads to reduction in amino acid of neera and it is observed on the first day of extraction due to production of microorganism and its innate auto fermentation property, and gradually as the day passes concentration of amino acids reduces gradually due degradation of protein content of neera. Third day a remarkable decrease in amino acid content was observed, but later presence of amino acid is not noticeable because of its minute concentration due to autolysis of amino acids (Jolly et al. 2006) [3,37].

Enzymatic activity in conversion of fresh neera into fermented sap

Due to ambient temperature and storage for a long time, yeast present in fresh neera produces invertase enzymes which break down natural palm sugar (sucrose) into glucose and fructose [25]. Glycolysis of monosaccharides occurs which convert monosaccharides into pyruvate. This process followed by conversion of two ADP molecules into two ATP and water molecules due to the different size of two molecules, NAD and NADH with the help of enzyme pyruvate decarboxylase and cofactor thiamine diphosphate, pyruvate is then converted to acetaldehyde and carbon dioxide (Dioha et al.,2009). On the other hand pyruvic acid which is the end product of glycolysis converted into lactic acid either by pyruvate decarboxylase or in some cases by the enzyme lactic acid dehydrogenase. (Figure 4-6)

Glycolysis

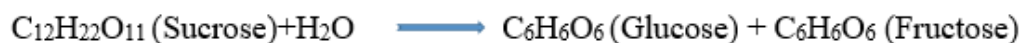


Figure 4: Glycolysis

Alcoholic fermentation



Figure 5: Alcoholic fermentation

By products

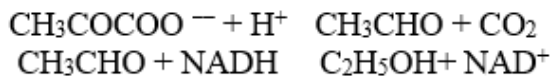


Figure 6: By products

Acetoin

Acetoin, 3-hydroxybutanone or acetyl methyl carbinol (Figure 7). It is an organic compound with formula $\text{CH}_3\text{CH}(\text{OH})\text{C}(\text{O})\text{CH}_3$.

Acetoin production during sap fermentation

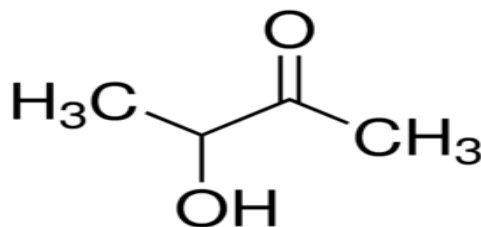


Figure 7: Molecular structure of acetoin

Acetoin is a colourless liquid with pleasant, buttery odour. Acetoin is normal by product of alcoholic fermentation (Romano & Suzzi, 1996), and its main sources are yeast and bacteria. The rate of production acetoin varies from wine to wine [27]. As compared to table wines palm toddy contains higher acetoin content. Acetoin is basically by product of carbohydrate metabolism, which formed in the presence of carbohydrate or of pyruvic acid. Acetoin is a normal product of alcoholic fermentation, fermentable carbohydrate or of pyruvic acid (Romano & Suzzi, 1996). From glucose by the process of glycolysis yeast forms pyruvate and the main reaction in the utilization of pyruvate is its decarboxylation to hydroxyethyl-thiamine PPI called the acetaldehyde TPP complex thiamine PPI (Figure 7). Acetoin is temperature and pressure dependent and increasing sharply by rise in fermentation temperature (Ough & Amerine, 1967). By rising temperature, rate at which acetolactate decomposes also increased, and more diacetyl and then acetoin are produced (Garcia, Garcia, & Diaz, 1994; Romano & Suzzi, 1996). That's the main reason of higher acetoin concentration in palm toddy. By increasing aeration level, large quantities of acetoin are being produced (Romano & Suzzi, 1996). Aeration conditions favours the accumulation of acetoin also increase the formation of higher alcohols, especially isobutyl alcohol and, to a lesser extent, isoamyl alcohol (Deiana et al., 1990) reported that acetoin production is affected by substrate, when substrate is glucose acetoin formed in large amount.

Microbial changes during fermentation

So many microorganisms especially large number of aerobic mesophiles feeding on palm sap due to sugar content of fresh sap. At the time of tapping, fermentation and storage of palm sap, lactic acid bacteria, yeasts, and acetic acid bacteria are widely found in sap (Nwachukwu et al. 2006; Ogbulie et al. 2007). Amoa-Awua et al. (2007) observed that immediately after tapping, multiplication of yeasts dominated by *S. Cerevisiae*. Quality change in fresh neera occur due to presence of different types of microorganisms at the time of natural fermentation. *L. mesenteroides* acidified the sap after first day of tapping. On third day alcoholic concentration of fresh sap increased due to increment in population of *Acetobacter* and *Gluconobacter* species of acetic acid bacteria. This increment in bacterial population from 0.42 to 0.48% between third and fourth day and then increased to acceptable level of 0.6%. As such there is no predetermined pattern in growth of microorganisms, it varies with palm sap, storage, season, geographical location. Freshly harvested neera contains around $4.8 \pm 0.9\%$ reducing sugar. Predominantly most of the

reducing sugars produced from hydrolysis of sucrose. Glucose and fructose are formed due to decomposition of sucrose by the action of invertase enzyme. These reducing sugars are utilized by the microbial population for their proliferation or division. In the fermentation of palm sap Lactic acid bacteria (LAB) and yeasts plays major role. Invertase enzyme is expressed by many yeast species and LAB. Along with production of invertase enzyme, yeasts are also known to express the enzymes responsible for production of alcohol from the reducing sugars (Theivendirarajah and chrystopher, 1987; Ngoc et al., 2013). Fresh sap contains 15% sucrose, due to fermentation sucrose converted into ethanol. At the time of natural fermentation physical and chemical changes occur. Gradually specific gravity drop down. Along with specific gravity pH also decreases parallelly. These changes occurring due to dominant lactic acid fermentation phase which favours or provide more suitable pH for increased invertase activity. The invertase enzyme plays very crucial role in breakdown of sugars into its monosaccharide form. In the time scale main reason of the changes are presence of lactic acid bacteria among the isolates identified in the first 20 h. The swift drop in pH is followed by inversion of sugars and increase in ethanol production which occurred at constant pH. Almost it takes 5 days for maximum ethanol concentration to be achieved [35]. At this stage high population of yeasts where *Saccharomyces chevalieri* is being observed which is founded to be the most dominant organism. The acetification of fresh sap considered to be the very slow fermentation process. After the isolation of the *Acetobacteraceti* it takes 2 to 12 weeks for complete acetification to occur. This phase of fermentation is used for vinegar production [30]. When sap is allowed to self-ferment in open pots, it is very crucial step which leads to production of 4.5% acetic acid [15]. Sequences of changes observed because there is increase in microbial populations and the biochemical changes observed which is occurring in three stages during natural fermentation of fresh sap- consisted of an initial lactic acid fermentation, a middle alcoholic fermentation and a final acetic fermentation. The reduction of the pH by the lactic acid production probably enhanced growth and invertase activity of the yeasts, which enhance ethanol production. For acetic acid bacteria production, ethanol produced by the yeasts act as the raw material [4].

Pasteurization of neera

Neera which is tapped from coconut palm, it can be pasteurized and bottled at 76°C to 79°C . It helps in preservation of its natural flavour (Naknaen et al., 2016) [12]. To impart a cooked flavour Pasteurization

above 85°C or 87°C for 4 to 5 minutes is needed. Yeasts which are present in fresh neera sap which is the main causative agent of fermentation are killed by holding pasteurization for 25 to 30 minutes. Rate of fermentation of neera increased by the presence of air. Figure 8 demonstrates Preservation method of neera. To make pasteurization more effective sodium benzoate is added. By adding a small amount of citric or malic acid with sodium benzoate can increase the effectiveness of sodium benzoate, but these acids alone (pH 3.75) have no significant effect. The addition of malic acid gives the sap an off-flavour resembling that of apple juice (Baliga and Tvy 1961).

Volatile compounds of neera

Neera is full of Volatile compounds. Volatile compounds are organic chemicals that have a high vapour pressure at ordinary room temperature. At the time of fermentation, acids and volatiles are present in the sap which leads to occurrence of harsh odour and astringency in fermented sap. It contains distasteful odour and has exceptionable harsh odour unpalatable in spite of being nutritious during fermentation (Grosch 1993). Process of heating of fresh sap to obtain palm sugar due to the presence of polar side chain amino acids such as glutamine and asparagine and sucrose in large amount leads to formation of volatile compounds and

more number of free amino acid groups are being released during Maillard reaction (SohnandHo1995) [3]. Neera possess in total 30 volatile compounds which is grouped into 4 major chemical classes and these are N-heterocyclic (17 pyrazines compound), O-heterocyclic (7 furan derivatives compound), as well as non-heterocyclic: aldehydes (4) and ketones (2). Odour threshold in water and flavour attributes of particular compounds are very important aspects for any food item. Pyrazine possesses an earthy, baked potato-like flavour (Maga., 1992). Also it is observed that 2,3-diethyl-5-methyl pyrazine and 5-methyl-6,7-dihydro-5H-cyclopentapyrazine volatile compounds are along together formed at 180 min of heating time. In spite of very low RPA approx. 0.5% these volatile compounds have potential aroma effect which is predominantly responsible for palm sugar aroma. Predominantly pyrazines are parallelly correlated with sensory attributes like nutty, earthy, roasty and potato like which contributes to its typical aroma. Formation of pyrazine compound requires minimum 120 min reaction time. Temperature required for formation of various pyrazines compound is 110°C which gives typical roasted nut aroma of palm sugar.

Maillard Reaction

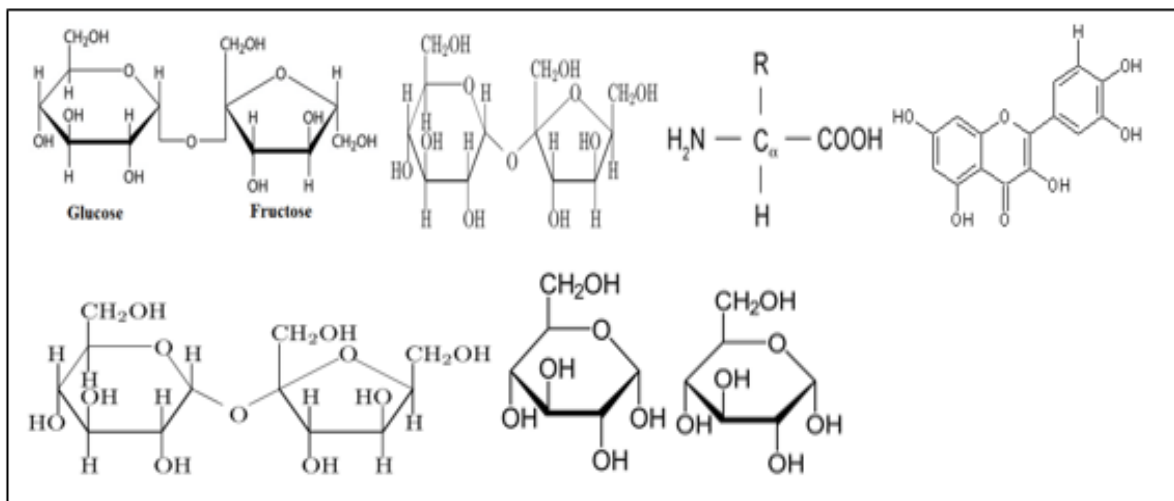


Figure 8: Maillard reaction compounds

Polyphenols are widely studied because of its inbuilt property of quality-preserving and its antioxidant effects in fruits and vegetables (Shahidi and Wanasundara 1992). Fruits and vegetables are main source of phenolic compounds with potential health benefits. They are efficient hydrogen donors, which is the main reason of its antioxidant properties (Ricevanset al. 1995). There are so many researches have been done to identify ratio of polyphenolic content and ascorbic acid content in fresh and naturally fermented saps. They concluded that Fresh sap has lower polyphenol content, but a higher ascorbic acid content than naturally fermented sap. In various forms of neera like (i) fresh, (ii) fermented and (iii) clarified neera sap, different volatile compounds are present. Fresh neera possess the maximum proportion of volatile compound 21 compounds (5.33 ppm), approx. compose of more than 98% of the volatiles from fresh neera. Clarified neera contains less quantities of volatiles approx. 13 compounds (1.31 ppm), constituting more than 97% has been identified. Fermented neera composed of more than 95% of volatile compounds, which contains approx. 12 compounds (37.4 ppm). Components responsible for flavour retention are 2-hydroxy-3-pentanone, 2-methyl tetrahydrofuran, ethyl lactate, 1-hexanol, phenyl ethyl alcohol, 2-methyl tetrahydrofuran and 3-hydroxy-2-pentanone. Harsh and abstemiousness taste of toddy or fermented sap is due to increased amount of acid (19.0 mg/l), like majorly due to dodecanoic

acid (19.0 mg/L) and palmitoleic acid, along with higher concentration of ethyl alcohol and ethyl esters are present. The fresh neera has been found to have principle volatile compounds such as phenyl ethyl alcohol, ethyl lactate, 3-hydroxy-2-pentanone, ethyl lactate, farnesol, tetradecanone, and 2-methyl tetrahydrofuran [8]. There are 3 compounds which have been retained among 7 compounds from fresh neera and these compounds are, phenyl ethyl alcohol, ethyl lactate and farnesol [8]. There are so many volatile compounds present in neera and they are classified as ester, aromatic hydrocarbons, aliphatic ketones, alcohols, acids, and heterocyclic compounds [8]. 2-butanol and acetic acid were the major volatile components identified in the fresh sap (Purnomo., 2007). Before sugar processing, a natural fermentation may occur, leading to physical and microbiological changes. There are three stages of the fermentation, namely initial lactic acid fermentation, a middle alcoholic fermentation, and a final acetic acid fermentation (Tomomatsu et al. 1996) [4,8]. Due to the different level of fermentation process, which may occur prior to the processing, the quality profile of the sugar produced by farmers may vary. Ethyl lactate, phenylethyl alcohol, and farnesol were among the seven compounds which are present in both fresh and fermented sap. The increased amounts of acids such as palmitoleic acid and dodecanoic acid (19.0 mg/L) and higher concentrations of ethyl alcohol and ethyl esters cause astringency and harsh note to fermented sap [8]. 3-isobutyl-2-

methoxypyrazine (earthy), acetoin (buttery), ethylhexanoate (fruity) and 2-acetyl-1-pyrroline (popcorn like) are important odorant of palm toddy. Ethyl alcohol content in fresh neera, fermented neera and clarified neera are found to be as 0.07%, 2.56% and 0.06% respectively (Table 4, Fig 9).

Odorants present in fermented sap

Major odorants of palm toddy are 3-isobutyl-2-methoxypyrazine (earthy), acetoin (buttery), ethylhexanoate (fruity) and 2-acetyl-1-pyrroline (popcorn like) and important flavour components of palm juice are ethyl lactate, 3-hydroxy-2-pentanone, and ethylhexanoate. There are several compounds which are responsible for aroma of palm juice and these compounds are ethyl lactate, phenylethanol, 3-hydroxy-2-pentanone, farnesol, 3-methyl tetrahydrofuran and tetradecanone [8]. Volatile compounds present in palm sugar estimated by treating neera with thermal process. Analysis of the volatile compounds of the thermally treated palm juice using headspace solid-phase micro extraction method yielded approx. 30 odour-active compounds. These compounds were conveniently grouped into four major classes. The four chemical classes were N-heterocyclic (17 pyrazine compounds), O-heterocyclic (7 furan derivatives), aldehydes (4) as well as ketones (2) (Table 2). Higher temperature of above 110°C led to a nearly exponential increase in the formation of pyrazine compounds and the typical roasted nut aroma of palm sugar (Ho et al., 2007).

Flavour isolation of fresh neera

To isolate flavour from fresh neera Likens-Nickerson simultaneous distillation-cum-solvent extraction apparatus is being used. There are 2 round bottom flasks connected by tube. Neera (1L) is placed in a 2 l round-bottom flask accompanying standard (ethyl caproate). In Another 250 ml round bottom flask, dichloromethane (100 ml) is added. These 2 flasks joined by 2 arms of Likens-Nickerson simultaneous distillation-cum-solvent extraction apparatus which has condenser and a cryogenic liquid for circulation. At 15°C the temperature of coolant is being maintained. For three hours constant heat is provided to the both flasks for extraction of flavour. After the extraction, by using a Vigreux column on a water bath with the chilled water circulation for removal of solvent is extensively used. After solvent removal 5 ml of extract is collected and further concentrated to 0.05 ml by flushing with nitrogen. For clarified neera and fermented neera this experiment is repeated. At 4°C volatiles of fresh, clarified and fermented neera were isolated and preserved for further processing [8].

Methods for neera isolation

To isolate and analyse volatile compounds Gas Chromatograph (GC) (Perkin Elmer instruments, Auto system XL), equipped with mass

spectrometer (Perkin Elmer instruments, Turbomass Gold) is being used enormously. In this apparatus Helium is the carrier gas flow at a rate of 1 ml/min [9]. Temperature of the injector port is maintained at 35°C for 2 min and then increased to 90°C at the rate of 3°C/min and further increased to 220°C at the rate of 2°C/min. By the help of splitless injection mode 2 µL of the sample is being injected at 70 eV ionization voltage. Kovats method is being used to determine retention indices (is used to convert retention times into system-independent constants) for all the compounds, n-alkanes are being used as standards. By comparing retention times of the GC peaks with reference compounds run under identical conditions also by comparison of retention indices with literature data flavour compounds are being identified. Fragmentation patterns in mass spectra were matched with those of the NIST62-LIB library and published mass spectra. Compounds were quantified using the internal standard method [8].

Alkaloid and flavonoids in neera

Phenolic compounds composed of one (phenolic acids) or (polyphenols) aromatic rings with attached hydroxyl groups. Antioxidant activity totally depends on hydroxyl group and phenolic ring. Phenolic antioxidants have chemo protective effects. Phenolic compounds are responsible for colour, sensory, nutritional, and antioxidant properties of foods. Free radical helps in scavenging dead cells. Antioxidant property of phenolic compounds helps in scavenging free radicals. Flavonoids are considered as powerful antioxidants with anti-inflammatory and helps in boosting immunity. Parallely it has other biological activities like from caffeic acid (orally bioavailable, hydroxycinnamic acid derivative and polyphenol, with potential antioxidant, anti-inflammatory, and antineoplastic activities). It is the most prominent naturally occurring cinnamic acid) which is involved in immune regulation, asthma, and allergic reactions (Koshihara et al., 1984).

There are 5 acids present in fresh sap. These are protocatechuic acid, gallic acid, p-coumaric acid, caffeic acid and galangin. In fresh sap these five phenolic compounds are present in less amount than fermented sap. Among all (350 lg/L) Gallic acid is one of the most abundant phenolic acid in the plant kingdom. It is a colourless or slightly yellow crystalline compound, predominantly present in fresh sap. In contrast caffeic acid content (730 lg/L) is higher in fermented sap. At the time of fermentation, its phenolic content starts increasing from 0.33 g/L of fresh sap to the peak 1.24 g/L at 58 h of fermented neera. Then there is no significant change [34]. The main reason behind rise in phenolic content is that there is binding of plant polyphenols with protein, sugar, starch, and cellulose, and formation of glycosidic bonds. Phenolic compounds are also produced due to the metabolism of some microorganisms [34]. (Table 5, Table 6)

Phenolic content	Quantity (g/L)	h
Fresh sap	0.33	0
Fermented sap	1.24	58

Table 5: Phenolic content of fresh sap and fermented sap

Parameters	Fresh coconut inflorescence sap (FCIS)	Naturally fermented coconut inflorescence sap (NCIS)
pH	7-7.4	3.3-5.9
Acidity (mg/L)	15.0 ± 0.8	18.0 ± 0.5 -177.0 ± 9.1
Phenolic content (ug/L)		
Gallic acid	350±1.36	500±1.51
1. Protocatechuric acid	86±0.37	210±1.02
2. Caffeic acid	56±0.21	730±1.29

3. P- coumaric acid	27±0.13	150±0.98
4. Galangin	100±0.65	120±1.07
Colour	oyster white	Cloudy whitish
Flavour compound		
Amino acid content	High	Low
Taste	Sweet	Sour, cider like taste
Flavonoids		
Shelf life	Processed – up to 6 months Unprocessed	Processed-1 day Unprocessed
Aromatic alcohols (ug/l)	0	196.20
Phenolic compounds (ug/l)	145.38	0
Aliphatic hydrocarbons (ug/l)	411.326	0
Esters(ug/l)	20.84	1032.76
Carbonyl compounds(ug/l)	4.12	2249.65
Sucrose content	14.35%	1.04%
Glucose content	0.28%	8.72%
Fructose content	0.32%	5.75%

Table 6: Comparative parameters of fresh and fermented sap

Plasma bubbling technique to inactivate microbes in neera

Plasma bubbling is a potential application for production of free radical and effect of production of free radicals on microbes present in neera. Main purpose of this technique is to preserve the nutritional value of fresh sap. This technique is widely used in the beverage industry. Cold plasma technique is non thermal processing which serves as an alternate tool to inactivate microbes at room temperature by reducing detrimental effects on colour, nutrition and other properties (Dasan Boyaci, 2018). At the time of plasma bubbling a comparatively large-sized stable and transient bubble is formed which causes the water (~80%) in neera to dissociate into hydroxyl radicals and hydrogen like atoms. Mainly, these reactive species occur inside the bubble and in the gas-liquid interphase they are more concentrated. Plasma bubbling helps in better distribution of the reactive species, resulting in uniform dispersion of the antimicrobial effect. Cold plasma treatment is being used to evaluate the presence of free radicals. Electron Paramagnetic Resonance (EPR)/Electron Spin Resonance (ESR) technique is being used. It is a kind of selective analytical tool to detect and quantify excited species having unpaired electrons, generally free radicals (Wu et al., 2012, Aparajitha and Mahendran., 2019). It is observed that in plasma bubbling process rate of flow of plasma into neera increased, rate of bubbles coalition noted as more but in contrast microbubble formation noted as less. Macro bubbles are formed by the process of coalescence (temporary combination) of two or more microbubbles (Duineveld 1996), due to coalescence it leads to increasing pressure inside these bubbles causing their surface to thin and deform. These bubbles form a big bubble when the thickness of this surface goes below 0.1 μm . Gradually there is a linearly increasing effect on rate of flow on bubble diameter. At higher rate of flow, the number of macro bubbles noted as higher leads to more significant cavitation pressure. Number of bubbles increases due to which the surface area of

the bubble becomes more extensive. The production of hydroxyl radicals based on high pressure and temperature given to the bubbles, due to which accumulation of reactive species inside the bubble increases. These bubbles burst when they reached their threshold size and this phenomenon is usually called hydrodynamic cavitation. Production of hydroxyl radicals these reactions are common at the bubble-liquid interface. At the centre of the bubble concentration of the generated free radicals like OH%, H% noted as highest in ultrasound treatment (Riesz et al., 1985). These larger sized bubbles accumulated several free radicals inside them and when they burst with such high pressure, their antimicrobial effect is amplified when compared to lower flow rates (Aparajitha and Mahendran., 2019).

Nutritional analysis of neera after plasma bubbling technique

It is observed that there is no deterioration of nutritional value of neera, very negligible loss is noticed. Vitamin C content is slightly decreased due to high concentration of the reactive oxygen and nitrogen species generated by cold plasma treatment. Hence, cold plasma treatment is very efficient technology that can be used without deterioration of nutritional profile by preserving all nutrients. Plasma action lead to microbial death, that's why it is widely used (Aparajitha and Mahendran., 2019).

Determination of chemical composition of postharvest coconut inflorescence sap during natural fermentation

Thin-Layer Chromatography (TLC) showed that sucrose is only sugar present in Fresh Coconut Inflorescence sap (FCIS). After 7 h of neera collection due to natural fermentation Fructose ($R_f = 0.51$) and glucose ($R_f = 0.47$) are detected. After 58 h of neera collection no sucrose is being detected. Along with time sucrose content gradually decreased due to its decomposition. At the time of natural fermentation inversion of sugar

occurs [2]. Total sugar dropped steadily, until day 3 reducing sugar increased constantly but after wards quickly decreased. This is due to conversion of sucrose into glucose and fructose. Reducing sugar is being consumed by microorganisms at the later stage. From day 1 to 5 ethanol content increased significantly and achieved its maximum of 90 g/kg at day 7 but it decreased later [5].

Effect of processing changes of vitamin C and total phenolic contents of PCIS during natural fermentation

Vitamin C is an important indicator to measure juice quality, it is very much prone to oxidation due to which it degrades easily. Phenolic compounds are also present in good quantity in fresh coconut sap. They contain phenolic hydroxyl groups [34]. Phenolic compounds and Vitamin C are very important antioxidant agents that help in protecting bio macromolecules from the damage caused by free radicals. They perform major functions like- antiaging, antitumor and antimutagen functions

(Chimi et al., 1991; Nardini et al., 1995; Milic et al., 1998). The vitamin C content of FCIS was 20.4 mg/L. It gradually reduced slowly on day 1 of fermentation, but rose on day 2 then on the 3rd day reached its maximum of 20.7 mg/L. This rise in Vitamin C concentration due to yeast activity which synthesizes Vitamin C in fermentation (Bremus et al., 2006). The Vitamin C fell down sharply after day 3, due to decreased activity of yeast. Yet, after day 5, the Vitamin C almost stopped decreasing which might be the protection of Vitamin C by antioxidant phenolic compounds. The total phenolic content of FCIS was 0.33 g/L. It increased slowly from day 1 to 2 of fermentation and rapidly thereafter reached a peak value of 1.24 g/L at 58 h. Afterwards it showed very minute changes. The increase of phenolic content might be caused by plant polyphenols binding with sugar, protein, cellulose and starch and forming glycosidic bonds. At the time of natural fermentation, acids produced cause degradation of glucoside bonds (Table 7 and 10).

Vitamin	
Vitamin C(Ascorbic Acid mg/100 mL)	16-30
Vitamin B1 (Thiamin) mg/dl	77.000
Vitamin B8 (Inositol) mg/dl	127.700

Table 7: Vitamins in neera

Amino acid	Concentration/100 mL
Glutamic acidg/100 g	34.200
Aspartic acid	4 mg
Valine	2.19 mg
Threonine	3.95 mg
Alanine	2.78 mg
Methionine	12 mg
Leucine	0.47 mg
Isoleucine	2.19 mg
Histidine	99.6 mg
Cysteine	14 mg
Arginine	7 mg
Tyrosine	7.11mg

Table 8: Protein in neera

Minerals, Macro nutrients /100ml	Range
Potassium (mg)	146.1-182.4
Magnesium (mg)	2.900
Nitrogen	
Phosphorous (mg)	2.0-6.4
Sodium (mg)	69.4-117.5
Chlorine (mg)	47.000

Minerals, Micro nutrients/100mL	
Zinc (mg)	0.018-0.026
Iron (mg)	0.049-0.058
Copper (mg)	0.0

Table 9: Minerals in neera

Vitamins	Range
Vitamin C	500-1500 ppm
Vitamin B1	1000- 5000 ppm
Vitamin B2	200-800 ppm
Vitamin B3	100-1000 ppm
Vitamin B6	500-1500 ppm
Vitamin B7	5-15 ppm
Vitamin B9	5-15 ppm

Table 10: Vitamins present in neera powder

Chemical changes in fresh sap

Chemical changes occur in fresh sap due to presence of sugar, yeast, amino acids due to its innate property of auto fermentation. The microbiological and chemical compounds of Fresh Coconut Inflorescence Sap (FCIS) and Naturally Fermented Coconut Inflorescence Sap (NCIS) have been studied by many researchers. There is study being done on the basis of total sugar, ethanol, volatile acid, reducing sugar, amino acid, total phenolic contents, total acidity, and Vitamin C of coconut inflorescence sap during fermentation. Innate fermentation property of neera leads to increase in, total acid, volatile acid and total phenolic contents. Simultaneously decreases in total sugar contents are being observed during fermentation. Also reduction of amino acid for the first three days, and then no significant change is being recorded. Reduction in vitamin c content is observed. NCIS contains more concentration of phenolic compounds than FCIS, detected by HPLC than [34]. Also during fermentation Coconut Inflorescence Sap (CIS) contains 166 isolates of yeasts and 39 isolates of bacteria, 17 species of yeasts have been found (Tomomatsu et al 1996). Natural fermentation of CIS consists of three stages. (i) initial lactic acid fermentation, (ii) middle alcoholic fermentation, (iii) acetic fermentation. During each stage, the microbial activity and their chemical reaction helps the activity of the microorganisms in the next stage [5]. The acids present in CIS include lactic, acetic, tartaric, malic and citric acid, volatile acid mainly consists of acetic acid (Samarajeewa et al., 1985). As along with time, changes of total acid and volatile acid of PCIS during natural fermentation occur. The total acid increased constantly from day 1 to 3 and we believed it to be in the lactic acid fermentation. This increased slowly from day 4 to 5 until PCIS began its ethanol fermentation. This condition might therefore enhance the growth and invertase activity of the yeasts [4]. The total acid rose sharply after day 5, which could be the acetic acid fermentation

phase. Moreover, the volatile acid content increased slightly from day 1 to 5 and it increased sharply thereafter, which also showed that it was in acetic acid fermentation phase after day 5. These changes of the total acid do not however completely agree with the results of (Atputharajah et al., 1986) where the total acid content increased from day 1 to 5, but slowly decreased thereafter [4]. The difference might be due to the different microorganisms in CIS. Atputharajah et al. (1986) did not report the changes of volatile acid [5]. The amino acid content was 2.6 g/kg of FCIS. Due to the enormous production of microorganisms, amino acid content decreased gradually on day one. On day two very minute concentration of amino acid was found due to degradation of protein on day one.

Production rate of neera and fermented sap

Production of palm juice and toddy in other parts of the world are as follow, the Seychelles Islands (Indian Ocean) has estimated production levels of 10×10^6 L per annum (Perdrix et al., 1999) and both Sri Lanka and India has a reported production levels of 9×10^6 L per annum. Kenya's production level was estimated at 5×10^6 L per annum [23].

Neera powder

There are so many researches under process going on for formulation of neera powder. Neera powder comprises of proteins, fat, carbohydrates, vitamins and minerals. It is still a challenge to prepare stable neera powder from fresh coconut sap inflorescence by using the method spray drying or freeze drying process [33]. It also helps in treating nephrotoxicity by giving oral dose along with medication. Present invention which is going on also comprises neera powder helps in improving or treating liver which is damaged by over alcohol consumption, it also helps in improving endurance during exercise, improves muscle performance by administering the neera powder [39].

Minerals	Range
Potassium	4000-8500 ppm

Sodium	150- 250 ppm
Magnesium	145-242 ppm
Phosphorus	4-10 ppm
Zinc	1-3 ppm
Copper	0.5-5 ppm
Manganese	0.5-5 ppm

Table 11: Minerals present in the neera powder

Nutrient	Range
Carbohydrate	60 to 80%
Fat	0.5-1.5%
Protein	0.5 to 2%

Table 12: Macro nutrient present in the neera powder

Ongoing present invention related to reconstitution capability of neera powder with water, maintaining the same nutritional value of fresh coconut inflorescence sap. Neera in powdered form is stable at room temperature. Nephrotoxicity which is induced by gentamicin is clinically known as a nonoliguric renal failure with characterized change in serum creatinine levels and a hypo-osmolar urinary output. Various embodiments suggested that directing therapeutic effective amount of neera powder composition 250 mg to 10 g/day, has so many health benefits for sports person stressed people, aged population, kids, pregnant women, people under malnutrition, alcoholics, patients undergoing chemo/radio therapy, asthma patients, people with poor cognition, depression, anxiety and fatigue, patients with poor electrolyte balance, sodium-potassium imbalance, anaemia patients, inflammation, gastrointestinal disorders, liver disorders, skin problems and postmenopausal women.

Medical uses of neera

Antioxidant

Neera have potential antioxidant activities. Antioxidants help in scavenging free radicals, and delays aging and other diseases also. Free radicals are one of the reasons for cancer.

Healthy heart

Neera contains a high amount of potassium which helps in reduction of blood pressure also it contains plenty of vitamins and minerals which helps in reducing cholesterol and keeps our heart healthy. Potassium and sodium content ratio present in neera is 4:1, which helps in lowering blood pressure [7]. It Helps in decreasing oxidative stress because of presence of antioxidant vitamins C and A [7].

Good for diabetic patients

Neera is diabetic friendly drink because it has a very low glycemic index (35) also low in calories and plenty of minerals are present. Neera by products are also a healthy option for diabetic patients.

Anticancer property

Neera contains a lot of antioxidants and phytochemicals, like Vitamin A, B complexes and Vitamin C which helps in reducing oxidative stress and

helps in scavenging free radicals from the body. It is helpful for overall development and flush out the toxins. It prevents various types of cancer in the body. Like colon cancer, breast cancer, oral cancer, lung cancer and stomach cancer.

Improves bone health

Neera is high in calcium, which helps in mineralization and also prevents osteoporosis by preventing loss of bone. Help in improving the bone density.

Good for respiratory health

Neera has antibacterial and antiviral properties which helps in preventing throat infection. It helps in prevention of phlegm and mucus formation in the respiratory tract. Neera is rich in antioxidants which helps in prevention of oxidative damage to the respiratory tract which can be caused by free radicals.

Prevent liver disease

Neera helps in curing liver. Particularly liver problems which are caused by extreme alcohol consumption. Neera helps in elimination of acetaldehyde, which is the metabolic end result of liquor and poisonous chemicals. Which on accumulation damages the liver. Neera is diuretic in nature, regular consumption improves urination and helps in eliminating extra toxins and uric acid from the body.

Prevent Anaemia

A high amount of vitamin K, iron and Vitamin C are present which helps in preventing anaemia. As Vitamin C is present which helps in iron absorption in the body. Help in increasing haemoglobin level, which in turns helps in binding of oxygen and other essential nutrients in red blood cells (RBC).

Neera improves digestion

Neera improves micro-gut flora [24]. It has a soothing effect on health. Also helps in boosting immunity.

Functional properties of neera

Soothing to body

Neera is rich in Vitamin A, B complexes and Vitamin C, these vitamins have antioxidant properties and neutral pH, which makes neera a natural detoxifying drink. Neera has a cooling effect that cools body.

Good for healthy skin

Due to the presence of antioxidants, it delays aging. Keeps skin healthy for a longer time.

Low in glycemic index

The Glycemic Index of neera drink is 35, which is a very good option for diabetic patients.

Helps in weight loss

It is low in calories and a wholesome drink contains a lot of nutrients which is a good option for people looking for weight loss.

Beneficial by products of neera

There are so many products obtained from neera also they have high nutritional value and source of instant energy source.

Palm Jaggery

It is also known as palm Gur. To make Jaggery neera is being boiled at 110°C in a galvanized iron pan. Due to Caramelization neera gets transformed into viscous fluid, poured into large open containers and leave it for some time and allowed it to harden. Its taste is very much similar to Jaggery made up of sugar cane juice. It is more nutritive due to its medicinal properties. Its taste is slightly salty. It has a cooling effect over the body. It is not exposed to bone meal content which is used for whitening of processed sugar [36]. It retains all constituents of neera and is equally nutritious. The proximate composition of jaggery is moisture (8.97%), ash (3.25%), reducing sugar (3.41%), and total sugars (73.87%). Protein (1.41%) and organic matter (11.1%). It contains adequate amounts of Ca, low sodium and high potassium is prescribed for conditions like hypertension and oedema due to heart and liver diseases. In case of diabetic acidosis due to loss of potassium it is highly recommended, anaemia, post operate convalescence and as a general diuretic. The iron content varies from 5–10 mg/100g palm Gur. Palm Gur is an instant rich source of energy due to the presence of a high amount of glucose and sucrose in it. It contains vitamins like B₁₂ and C.

Palm candy

Initially neera is filtered to remove debris and allow it to boil in an alloy vessel, adding a small quantity of phosphate. Then for 2 hours it is heated at 110°C immediately after removal of sediments. It is heated at 110°C until it reaches honey like consistency. The viscous fluid is then allowed to cool and poured into the crystallizer. Traditionally after 45-60 days sugar crystals start forming.

Palm sugar

Palm sugar is considered as a natural sweetener which is made from neera. Palm sugar is being made by minimal processing also no food additives or chemicals are there in palm sugar [20]. Vacuum-drying allows materials dried in a reduced-pressure atmosphere to counter any undesirable effects and enhances a product's quality and nutritional value. Therefore, the vacuum-drying method could improve palm sugar's features. Also it is unrefined and rich in vitamins and minerals. Fresh sap from the tree is heated to evaporate the moisture content until a thick or viscous syrup is obtained, and this thick syrup is then further heated and reduced to crystals. In the market, palm sugar is available in the 3 forms: block, granular and liquid form. Palm sugar tastes like white sugar there is no much difference, palm sugar has little caramel flavour and its liquid state resembles with bee honey. It is also used in making traditional desserts. Palm sugar is extensively used in making these desserts - ice creams, puddings, panna cottas and soufflé - using the molten *nolengur*. Palm sugar is very popular substitute of white sugar because of its enormous nutritional properties. It contains very important minerals like phosphorus, potassium, iron, zinc, copper and manganese. Along with this small amount of phytonutrients such as polyphenols, flavonoids and anthocyanin and antioxidant also present which has anti-inflammatory and antibacterial property also delays aging by reducing free radicals in the body. It is rich in B vitamins, especially inositol which is needed for the formation of healthy cells, as well as thiamine, riboflavin, folic acid and choline. There are total 20 amino acids out of which, it contains 16 amino acids. Amino acids are the building blocks of proteins and are needed for cell growth and repair. Also amino acids are fuel of the immune system. It helps in boosting immunity. It has very low Glycemic Index (method of measuring how carbohydrates impact blood glucose levels) which is 35 as compared to honey at 55 and table sugar at 68. Diabetic patients can easily consume palm sugar without any worries or raising sugar level. A high GI means immediately after eating food carbohydrates present in food immediately get absorbed in the body thereby increasing the blood sugar level due to which the pancreas releases large amounts of insulin (Borah.,2017).

Components in palm sugar	In percentage (%)
Sucrose	12% w/w
Protein	0.24%
Fat	0.37%
Carbohydrate	98.89%
Calcium	0.08%
Phosphorus	0.06%
Iron	30 mg /100 g
Nicotinic acid	4.02 mg /100 g
Riboflavin	229 mg /100 g
Calorific value	398 Calories /100 g

Table 13: Palm neera sugar composition

Palm Syrup

To obtain thick consistency or to make viscous fluid neera is heated for approx two hours continuously. Then this viscous neera or thick sap

poured into clay pots. Ripe, dry and shelled tamarind fruits devoid of seeds are added to syrup. In 10 liters of syrup, 1 Kg of shelled tamarind fruit is required. The clay pot is closed tightly with cloth and vessels are

kept in a shock proof, cool and dry place. Sugar crystallizes on the sutures of tamarind and the fruits become delicious.

Palm cola

It is an aerated Palm cola is an aerated soft drink containing 11% sugar. Other than sugar it contains cola concentrate, citric acid and food colour. Impurities of palm sugar removed by boiling.

Confectionary

Palm sugar is extensively used in making chocolates and ginger toffee. At a temperature of 120°C a mixture of glucose and palm sugar is boiled. The heated mixture is put into trays and mixed with powdered citric acid. A mixture of colour and essence is then added. The entire mixture is mixed well and cut into slabs, allowed to cool and packed

Toddy

It is formed by auto fermentation of neera sap at ambient temperature due to presence of sugar, microbes, Yeast also due to presence of enzymes enzymatic reaction takes place. Toddy has 4% alcohol content and its alcohol content increases along with fermentation. Gradually it yields an

acidic and sourer product. To obtain defined flavour [21]. Best part of this beverage is that it ferments naturally after collected from the tree. There are so many products obtained by toddy like alcoholic liquor called palm wine, arrack or arak. Lime juice is rubbed inside the surface of clay pot which prevents fermentation of neera and sweet toddy, which yields concentrated or crude sugar molasses, palm candy, and vinegar.

Palm oil

It is extracted from the flesh of palm fruit. Palm kernel is found in the centre from which palm oil is extracted out. Basically oil is extracted from the mesocarp. Triglycerides are the major constituents of palm oil. Over 95% of palm oil consists of mixtures glycerol molecules, each esterified with three fatty acids (Sundram and Sambanthamurthi., 2003).

Neera based soft drink

Neera soft drink is the best alternative rather than aerated beverages. Chilled neera is considered a very nutritious drink. It contains vitamins, minerals, salts and acids like ascorbic acid, nicotinic acid, riboflavin, protein and Vitamin-C. It has very low calories despite being sweet and delicious (Figure 10).

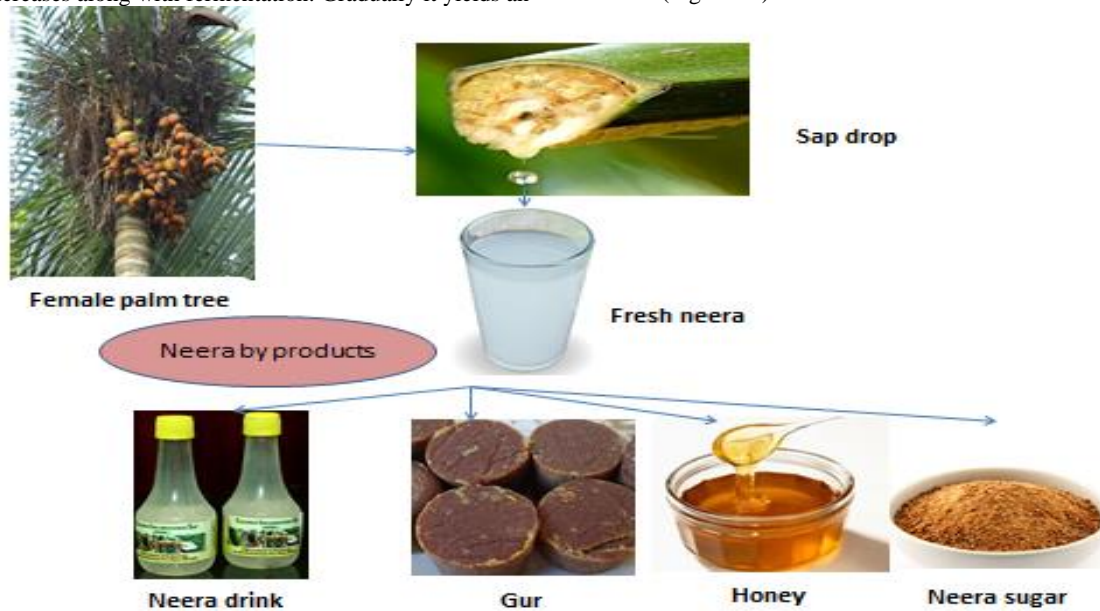


Figure 10: The Various nutrient rich products of neera

Neera based cookies

Neera cookies are popular among people. These cookies are made with flour, grated coconut and jaggery powder. As neera is low on glycemic index [35]. It is a good option for diabetic patients. It is a good healthy snacks option that will help in maintaining glucose levels in diabetic patients. Different types of cookies are being prepared by oats, multigrain, arrowroot, corn, whole wheat and fig flour.

Neera based Chocolate

It is a very good alternative for chocolate lovers because it is low in calories, low GI, full of nutrients. It is considered a very healthy option for all age groups especially for diabetic patients.

Neera based Sweet

This is a very popular and fruitful confectionery product for diabetic patients and sweet lovers. FeluModak which is produced and marketed by a very famous producer of sweets and sellers of West Bengal. The main ingredient of this sweet is predominantly kheer coconut sap or neera sweetener. It is called Kesharpeda, it is yellow in colour (Misra., 2016).

Consumer perception on neera

There has been survey conducted by taking responses from 108 respondents about awareness towards neera drink. Google form has been prepared and circulated among group.

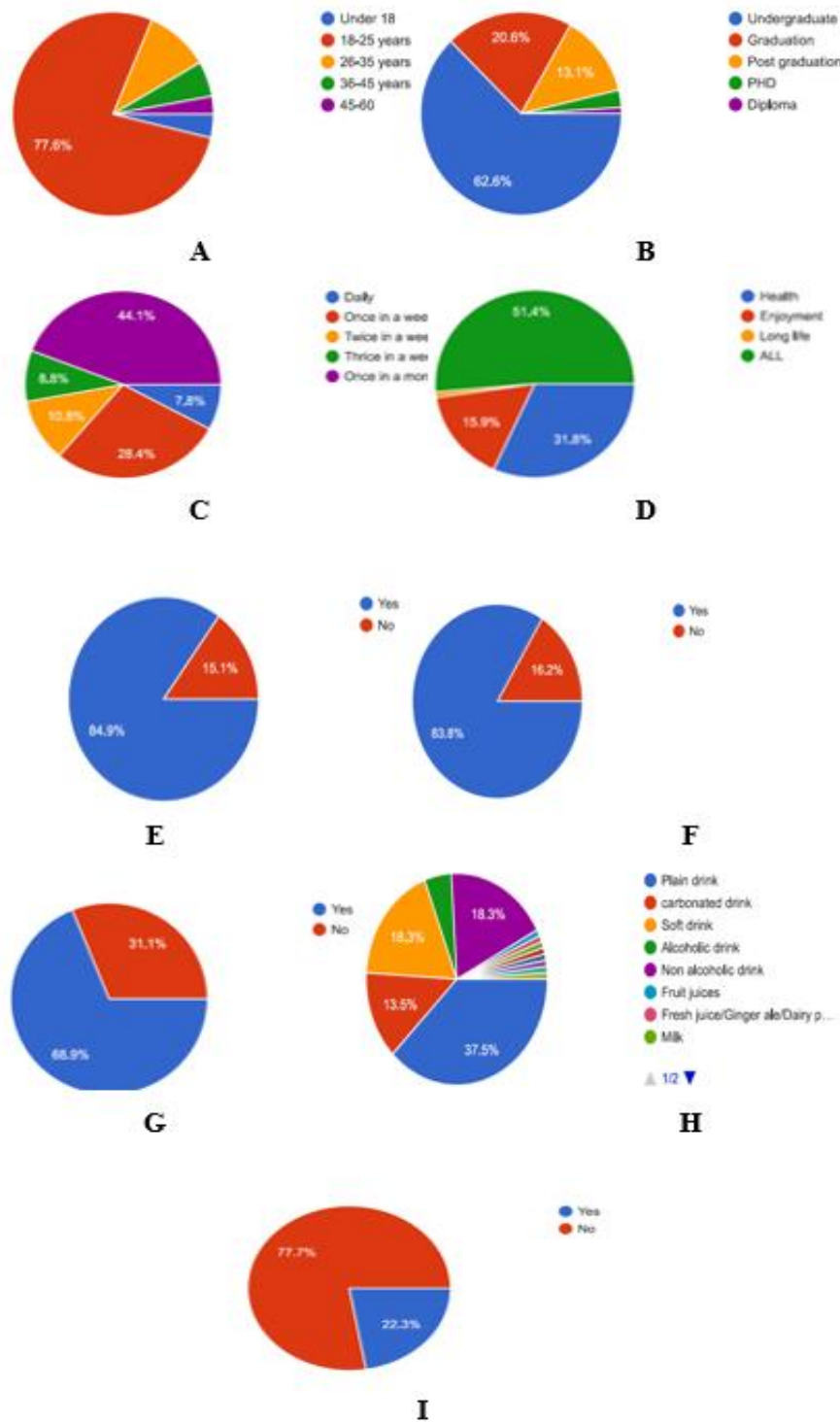


Figure 11(A): Distribution of survey population and various data details

As Figure 11 (A and B) depicts majority of respondents are come under 18-25 years age group, Minority population belongs to 45-60 years age group. As Figure 11 (C) depicts that maximum respondents are student, minority respondents are housewife. As Fig 11 (D) depicts maximum respondents consumes non-alcoholic beverage once in a month. Minimal consumption of neera drink is thrice in a week. As Fig 11 (E) depicts that maximum respondents consume beverage for good health, enjoyment, long life. As Fig 11 (F) depicts that maximum respondents are aware of

coconut water nutritional fact. Very few respondents are not aware of nutritional fact of coconut water. As Fig 11 (G) depicts that maximum respondents consumes clear liquid diet in contrast very few respondents from survey population don't consume clear liquid diet. As Fig 11 (H) depicts that maximum respondents are aware that coconut water availability in processed form. Very few respondents among survey population don't know about availability of processed neera. As Fig 11 (I) depicts that maximum survey population prefer plain drink.

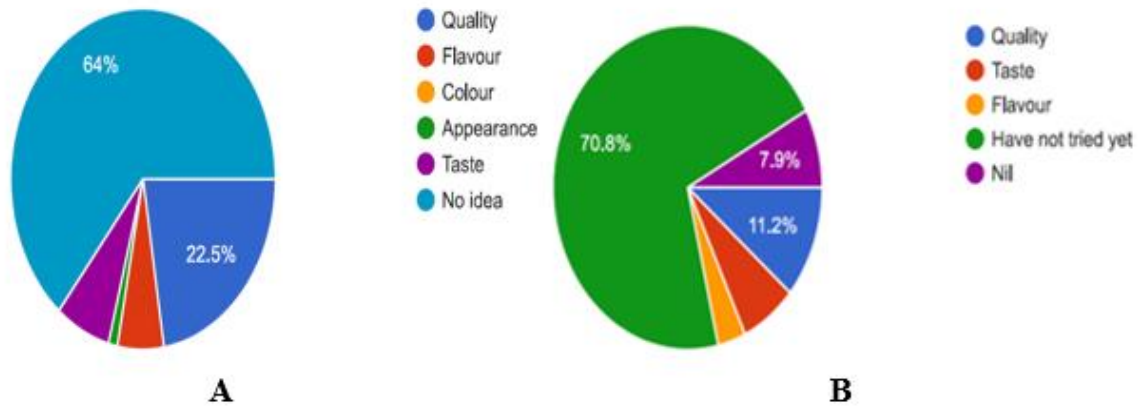
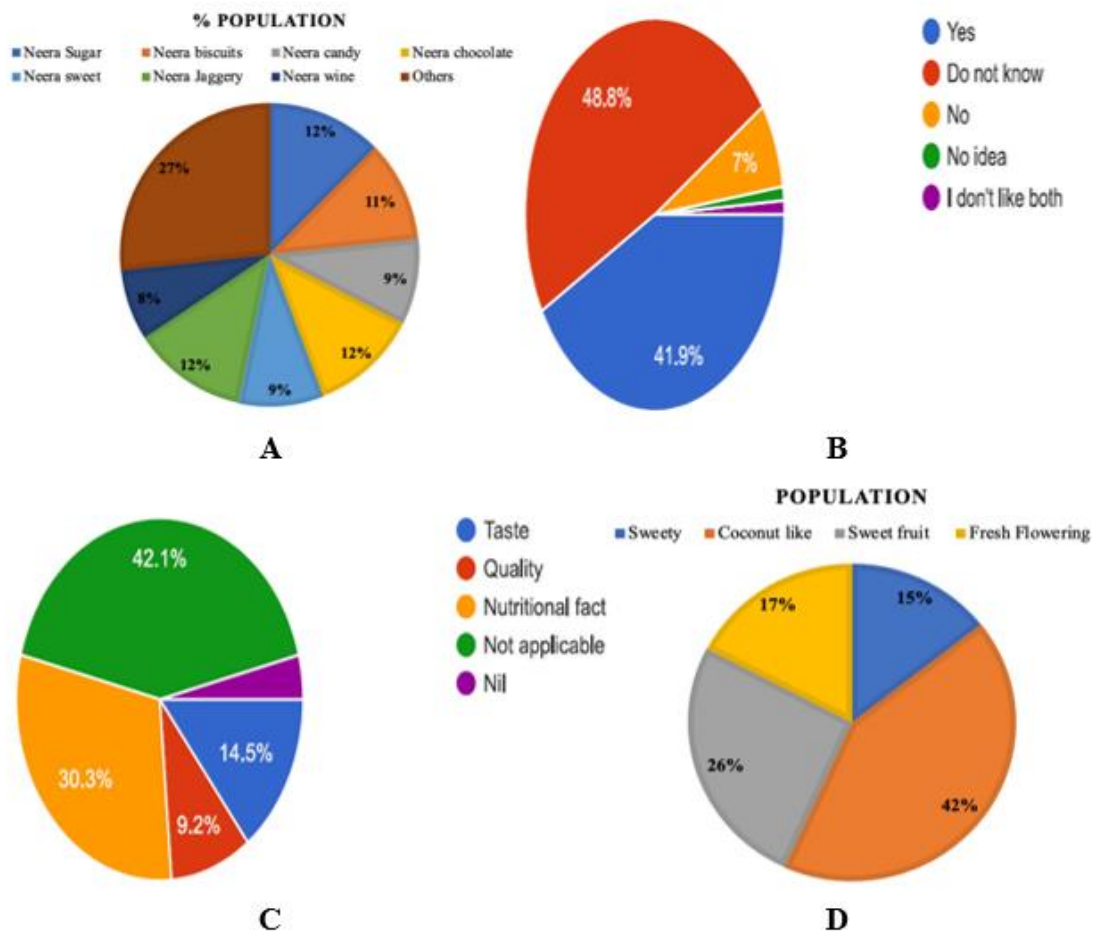


Figure 12: Reason for neera drink preference among survey population

As Figure 12A depicts that maximum respondents are not aware of best thing about neera drink. 22.5% respondents thinks best thing about neera drink is its quality. As Figure 12B depicts that maximum population have not tried neera so they don't have any idea about its taste.



Figures 14: A,B,C,D

As Fig 13 (A) depicts that maximum respondents have no idea about availability of neera products in the market. Still 23% respondents are familiar with neera sugar. As Fig 13 (B) depicts that maximum respondents don't know the preference of neera drink over aerated beverage. As Fig 13 (C) depicts that the maximum respondents don't prefer neera drink. Still 30% respondent prefer neera drink because of its

nutritional value. As Fig 13 (D) depicts that maximum respondents among survey population prefer neera in coconut flavour and least respondents prefer neera in fresh flowery flavour. Maximum respondents consumes non-alcoholic beverage like coconut water and soft drink, fresh juices. Once in a week, 68.6% respondents prefer fresh non-alcoholic beverage as compare to aerated beverage reason being to maintain good health also

to get rid of preservatives and artificial colouring agents present in processed or aerated drink. 85% respondents among survey population are aware of nutritional benefits of coconut water. 84% survey population consumes clear liquid fluid like coconut water. Sugarcane juices etc. 69% survey population aware of availability of processed coconut drink in the market. 37.5% survey population among all different kind of beverages prefer plain drink. 78% respondents are not aware of neera brands available in the market. Approx 64% respondents have no idea about qualities of neera drink. 45% survey population prefer tetra pack packaging for neera drink because of convenience. 70% survey population have no idea about neera drink. 50% survey population not aware about availability of neera products in the market. Among survey population 90% respondents are not aware of neera powder. 72% respondents are not familiar with neera toddy. Maximum respondents prefer neera drink while surfing internet. 49% respondents have no idea regarding preference of neera drink over aerated beverage, rest of respondents are in favour of neera because neera is full of nutrient already mentioned in the question. 71% respondents would suggest neera to sick patient because by filling this survey questionnaire they googled benefits of neera because neera drink is new to them. Conclusion is that maximum respondents never tried neera, so they are not aware about its benefits. Instead of this 30% respondents are aware of neera drink and its benefits because of its higher nutritional value. 58% respondents would love coconut flavour neera drink. As from the survey it is very clear that majority of survey population prefer clear drink and preference for coconut water is also high, also by this survey instead of maximum people do not know about neera drink, they googled this drink because of pandemic everyone looking for healthy option instead of processed artificial drinks.

Care, concern and safety in neera use

Rarely someone found to be allergic to neera consumption. If a person is allergic to neera, he or she may consume neera under the guidance of a physician or dietician. For maximum benefits neera should be consumed freshly. If pregnant women allergic to neera she should stop consuming neera.

Conclusions

Neera have very healthy, nutrition and functional phytochemical rich profile. Neera is rich source of minerals. The shelf life of neera is short and it get converted into toddy due to fermentation in short time. Neera possess 30 volatile compounds. There are protocatechuic acid, gallic acid, p-coumaric acid, caffeic acid and galangin present in neera. Fresh sap is neutral in nature in contrast fermented sap is acidic in nature. Glutamic acid is present predominantly in neera. In minerals it contains potassium in large proportion. Neera drink comprises of so many benefits, these are heart friendly, cooling effect, diabetic friendly, anticancer property, immunity booster, prevent anaemia, good for liver, good for bone health, improves digestion. Fresh sap is a rich source of asparagine and glutamine. It contains in total 17 amino acids which helps in maintaining proper acid/alkaline balance (neutral pH). It is highly perishable due to its auto fermentation property. It is considered as nutri-dense beverage because it contains crucial vitamins and minerals which is a helpful for overall growth.

References

- Aparajhitha, S., and Mahendran, R. (2019). Effect of plasma bubbling on free radical production and its subsequent effect on the microbial and physicochemical properties of Coconut Neera. *Innovative Food Science & Emerging Technologies*, 58, 102230.
- Apriyantono, A., Aristyani, A., Lidya, Y., Budiyo, S., and Soekarto, S. T. (2002). Rate of browning reaction during preparation of coconut and palm sugar. *International Congress Series*, 1245, 275–278.
- Ashraf-Khorassani, M., Coleman III, W. M., Dube, M. F., & Taylor, L. T. (2019). Isolation and Purification of Pyrazines Produced by Reaction of Cellulosic-Derived Sugars with NH₄OH and Selected Amino Acids. *Journal of Chromatographic Science*, 57(9), 784–789.
- Atputharajah, J.D., Widanapathirana, S., & Samarajeewa, U. (1986). Microbiology and biochemistry of natural fermentation of coconut palm sap. *Food Microbiology*, 3(4), 273–280.
- Atputharajah, J., Widanapathirana, S., and Samarajeewa, U. (1986). Microbiology and biochemistry of natural fermentation of coconut palm sap. *Food Microbiology*, 3, 273–280.
- Baliga, B. P., and Ivy, A. C. (1961). Pasteurization of palm sap (neera). *Journal of Agricultural and Food Chemistry*, 9, 149–151.
- Bhagya, D., and Gopan, S. (2016). Effects of coconut neera (*Cocos nucifera* L.) on blood pressure among hypertensive adult woman. *International Journal of Applied and Pure Science and Agriculture*, 2(9), 1–7.
- Borse, B. B., Rao, L. J. M., Ramalakshmi, K., and Raghavan, B. (2007). Chemical composition of volatiles from coconut sap (neera) and effect of processing. *Food Chemistry*, 101(3), 877–880.
- Davies, W. (1990). Gas chromatographic retention indices of monoterpenes and sesquiterpenes on methyl silicone and Carbowax 20M phases. *Journal of Chromatography*, 503, 1–24.
- Mandal, D. M., & Mandal, S. (2011). Coconut (*Cocos nucifera* L.: Arecaceae): in health promotion and disease prevention. *Asian Pacific journal of tropical medicine*, 4(3), 241–247.
- Devdas, R. P., Sundari, K., and Susheela, A. (1969). Effects of supplementation of two school lunch programmes with neera on the nutritional status of children. *Journal of Nutrition and Dietetics*, 6, 29–36.
- Flores-Gallegos, A. C., Vazquez-Vuelvas, O. F., Lopez-Lopez, L. L., Sainz-Galindo, A., Ascacio-Valdes, J. A., Aguilar, C. N., and Rodriguez-Herrera, R. (2019). Tuba, a Fermented and Refreshing Beverage from Coconut Palm Sap. In *Non-Alcoholic Beverages* (pp. 163–184). Wood head publishing.
- Fossi, B.T., Ekue, N.B., Nchanji, G.T., Ngah, B., Anyangwe, I.A., Wanji, S., (2015). Probiotic properties of lactic acid bacteria isolated from fermented sap of palm tree (*Elaeisguineensis*). *J. Microbiol. Antimicrob.* 7 (5), 42–52.
- Gibson, S., Gunn, P., Wittekind, A., and Cottrell, R. (2013). The effects of sucrose on metabolic health: a systematic review of human intervention studies in healthy adults. *Critical reviews in food science and nutrition*, 53(6), 591–614.
- Granados, D., Lopez, G., (2002). Management of the coconut palm (*Cocos nucifera*L.) In Mexico. *Chapingo Series Forestry and Environmental Sciences* 8 (1), 39–48.
- Gupta, R.C., Jain, V.K., Shanker, G., (1980). Palm sap as a potential starting material for vinegar production. *Res. Ind.* 25, 5–7
- Grosch, W. (1993). Detection of potent odorants in foods by aroma extract dilution analysis. *Trends in Food Science & Technology*, 4(3), 68–73
- Gupta, R. C., Jain, V. K., &Shanker, G. (1980). Palm sap as a potential starting material for vinegar production. *Research and Industry*, 25, 5–7.
- Hebbar, K. B., Pandiselvam, R., Manikantan, M. R., Arivalagan, M., Beegum, S., and Chowdappa, P. (2018). Palm sap—Quality profiles, fermentation chemistry, and preservation methods. *Sugar Tech*, 20(6), 621–634.

20. Huynh Thi Le, D., Lu, W. C., & Li, P. H. (2020). Sustainable Processes and Chemical Characterization of Natural Food Additives: Palmyra Palm (*BorassusFlabellifer* Linn)
21. Jose, N., Deshmukh, G. P., and Ravindra, M. R. (2018). Neera- A Potential Natural Health Drink. *Biomedical Journal of Scientific & Technical Research*, 11(3), 8595-8597.
22. Jose, S. P., Mohanan, R., Sandhya, S., Asha, S., and Krishnakumar, I. M. (2018). A novel powder formulation of coconut inflorescence sap inhibits alcoholic liver damage by modulating inflammatory markers, extracellular matrix metalloproteinase, and oxidative stress. *Journal of Food Biochemistry*, 42, e12543.
23. Kadere, T.T., Miyamoto, T., Oniango, R.K., Kutima, P.M., Njoroge, S.M., (2008). Isolation and identification of the genera *Acetobacter* and *Gluconobacter* in coconut toddy (mnazi). *Afr. J. Biotechnol.* 7 (16), 2963–2971.
24. Kalaiyarasi, K., Sangeetha, K., Rajarajan, S., (2013). A comparative study on the microbial flora of the fresh sap from cut inflorescence and fermented sap (toddy) of *Borassusflabellifer* Linn (Palmyrah tree) and of *Cocos nucifera*Linn (coconut tree) to identify the microbial fermenters. *Int. J. Res. Pure Appl. Microbiol.* 3 (3), 43–47.
25. Konan, Y., Konan, J.L., Konan, R., Assa, R., Okoma, J., Issali, E., Biego, M., (2015). Changes in physicochemical parameters during storage of the inflorescence sap derived from four coconut (*Cocosnucifera*L.) varieties in Cote D' Ivoire. *Am. J. Exp. Agric.* 5, 352–365.
26. Kurniawan, T., Jayanudin, J., Kustiningsih, I., and Firdaus, M. A. (2018). Palm sap sources, characteristics, and utilization in Indonesia. *Journal of Food and Nutrition Research*, 6(9), 590-596.
27. Lasekan, O., and Abbas, K. A. (2010). Flavour chemistry of palm toddy and palm juice: a review. *Trends in Food Science & Technology*, 21(10), 494-501.
28. Misra, B. (2016). Neera: The coconut sap: A review. *International Journal of Food Science and Nutrition*, 1(4), 35-38.
29. Naknaen, P., Meenune, M., (2016). Quality profiles of pasteurized palm sap (*Borassusflabellifer*Linn.) collected from different regions in Thailand. *Walailak J. Sci. Technol.* 13, 165–176.
30. Nathanael, W. R. N. (1966). Ceylon Coconut Planters' Review, 4, 87–89.
31. Ramaswamy, P., N Ramaswamy, L. (2017). Organoleptic Acceptability, Selected Nutrient Content and Physicochemical Characteristics of Coconut Neera on Storage. *Journal of Food Science and Engineering*, 04, 003.
32. Wraage J, b, Burmester S, Kuballaa J, Rohnb S. (2019). Coconut sugar (*Cocos nucifera*L.): Production process, chemical characterization, and sensory properties. *LWT-Food Science and Technology* 112, 108227.
33. Raveendran, S.R., Thankappan, R., (2012). Protective and curative effects of *Cocos nucifera*inflorescence on alloxan-induced pancreatic cytotoxicity in rats. *Indian J. Pharm.* 44, 555–559.
34. Xia, Q., Li, R., Zhao, S., Chen, W., Chen, H., Xin, B., Tang, M., (2011). Chemical composition changes post-harvest coconut inflorescence sap during natural fermentation. *Afr. J. Biotechnol.* 10, 14999-15005.
35. Samaraieewa, U., Mathes, D.T., Wijeratne, M.C.P., Warnakula, T. (1985). Effect of sodium metabisulphide on ethanol production in coconut inflorescence sap. *Food Microbiol.* 2 (1), 11-17.
36. Saranya, P., Vijayakumar, T., (2016). Preliminary phytochemical screening of raw and thermally processed Palmira palm (*Borassusflabellifer*) fruit pulp. *JIPBS* 3, 186-193.
37. Shetty, P., D'Souza, A., Poojari, S., Narayana, J., & Rajeeva, P. (2017). Study of fermentation kinetics of palm sap from *Cocos nucifera*. *International Journal of Applied Sciences and Biotechnology*, 5(3), 375-381.
38. Somashekaraiah, R., Shruthi, B., Deepthi, B. V., & Sreenivasa, M. Y. (2019). Probiotic properties of lactic acid bacteria isolated from neera: A naturally fermenting coconut palm nectar. *Frontiers in Microbiology*, 10.
39. Svenia, J.P., Asha, S., Krishnakumar, I.M., Ratheesh, M., Savitha, S., Sandya, S., Girish, K.B., Pramod, C., (2017). Nephro-protective effect of a novel formulation of unopened coconut inflorescence sap powder on gentamicin induced renal damage by modulating oxidative stress and inflammatory markers. *Biomed. Pharmacother.* 85, 128-135.
40. Syamala Devi, N., Hariprasad, T., Ramesh, K., Merugu, R., (2015). Antioxidant properties of coconut sap and its sugars. *Int. J. Pharm. Tech. Res.* 8 (1), 160-162



This work is licensed under Creative Commons Attribution 4.0 License

To Submit Your Article Click Here:

[Submit Manuscript](#)

DOI: [10.31579/2637-8914/072](https://doi.org/10.31579/2637-8914/072)

Ready to submit your research? Choose Auctores and benefit from:

- fast, convenient online submission
- rigorous peer review by experienced research in your field
- rapid publication on acceptance
- authors retain copyrights
- unique DOI for all articles
- immediate, unrestricted online access

At Auctores, research is always in progress.

Learn more <https://auctoresonline.org/journals/nutrition-and-food-processing>