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CHEMICAL COMPOSITION OF MEAT (KERNEL) AND NUT WATER OF MAJOR COCONUT (*COCOS NUCIFERA* L.) CULTIVARS AT COASTAL AREA OF PAKISTAN

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Abstract

Three varieties of the coconut (Tall, Dwarf and Hybrid) were subjected to analyse for physicochemical properties of meat and nut water, Sodium (Na), Moisture %, Ash %, Calcium (Ca), Iron (Fe), Magnesium (Mg), Cobalt (Co), Potassium (K), pH, Volatile matters, Caloric value (CV) and Total dissolved solids (TDS). The chemical analysis of Meat (mature & immature stage) showed high percentage of Mg and Na in study varieties. However, it was apparent that major portion of stored Ca, Mg, and Na were lodged in the nut water. The nutrients Na, K and Ca were high or less evenly distributed in the Kernel and Water, whereas there was nutrient a comparatively greater concentration of P and Mg in the Water. The K (56% to 81%) was higher in nut water as compared to other ones. The results showed Mg 45% to 70% and Na 1% to 53% in mature and immature meat, respectively.

Introduction

Coconut (*Cocos nucifera* Linn.) is widely known as the tree of life, due to its significant contribution to human life from all of its meat, water, husk, shell, wood, leaves, spikelet, etc. Every part of the palm is utilized for the benefit of human race and its fruit particularly provides important constituent of food which is indispensable in every household (Magat, 1999). Fibers from the husk are used for brushes, mats, twine, rope, stuffing for mattresses and upholstery, and for caulking boats (Anon., 1990). Coconut is currently grown in nearly 90 countries spread along the tropical belt; about 10 million families rely on coconuts as their main source of food and incomes (Anon., 2004).

The health and nutritional benefits that can be derived from consuming coconuts are unique and compelling. Coconuts are used freely as a refreshing drink and as an ingredient of confectionary, ice, biscuits, cakes and bread. Coconut oil is used as cooking oil, hair oil and lamp oil and as an essential ingredient in soap making (Nathaneel, 1960). In the feeding experiments for malnourished children conducted in one of the poorest areas, coconut oil proved to be better source of dietary fat compared to soybean. Also worth mentioning was the use of coconut-based activated carbon in cleaning the Chernobyl victims system from radioactive elements (Eyzaguirre, 1996). The kernel of the mature coconut is rich in oil and in fact most valuable part of fruit, as it provides important ingredient of food. Sample of the fresh kernel have been found to consist an average of 48.0% moisture, 35.5% oil and 16.5% oil free residue (Nathanael, 1960).

Santoso *et al*., (2007) analyzed that coconuts (matured coconuts with broken meat particles in the watery endosperm due to abnormal formation of kernel during the development of fruits) were analyzed for their proximate composition, minerals, vitamins, dietary fibres, sugars, organic acids, fatty acid composition and amino acid profile.

The water from the tender coconut has a pleasant sweet taste and is a refreshing drink. The principle inorganic constituent of nut water is potash. Promoting use of tender nut as a source of health drinks and nutrition food will open up new opportunities for improving profitability of coconut farming. People in both the coconut producing and non-producing countries are becoming more and more health conscious and are inclined towards consuming natural products instead of synthetic ones (Thampan, 1996). The Coconut water found inside young coconut as biological pure, tasty and full of the salts, sugars and vitamin that are very beneficial for athletes (Anon., 2000a).

Coconut water is composed of many amino acids, nitrogenous compounds, inorganic elements, organic acids, sugars and their alcohols, vitamins, growth substances (Cytokines and auxins) and many other unknown components (George, 1993). Coconut water was evaluated as rehydration fluid in diarrhoea. Oral rehydration has been recommended in patients with diarrhoea to replace the fluid loss from gastrointestinal tract (Khan *et al*., 2003). Jacson *et al*., (2004) reported in his publication that fat, protien, soluble solds, acidity and turbidity also increased steadily with maturity, while pH and ash showed variation throughout maturation.

Nut water samples from Malayan dwarf coconut and fancy king coconut varieties have also been examined and found to show during development a similar cycle of change to the palms, but the sugar concentration at the maximum were higher. The drinking stage total sugars would amount to over an ounce per fruit and there is little reason to doubt that they consist of glucose, fructose and sucrose (Nathanael, 1952; Child & Bnathanael, 1947). The use of coconut water resulted in longer sub-culturing time and the production of highly robust plants which were able to survive in green house conditions (Asma *et al*., 2008).

The quality of nut water and kernel of tender coconut show wide inter cultivar variation. Some cultivars are known to produce good quality tender coconut characterized by having a high content of total sugars in the water and tasty kernel. The purpose of the study was to examine the quantity of minerals/trace metals in the coconut Kernel and nut water in various cultivars. Such cultivars could be identified and multiplied for raising gardens as source of good quality tender nuts. Present study also identified the cultivars on the bases of the chemical analysis of the kernel and nut water during the maturation period and raising the nursery of good quality of cultivars.

Materials and Methods

Sample collection: Samples of seed nuts were collected from coconut varieties grown in coastal Agricultural Research Station, PARC, Karachi. Samples were based on area of cultivation and the stage of maturation 6-7 months and 11-12 months SLT: Sri Lanka Tall, MYD: Malayan Yellow Dwarf, Hybrid (T x T). On arrival at the laboratory, outer husk was removed and water was transferred in to a new and cleans polythene bottle through an eye of middle hard shell. Filtered through glass wool, placed in to a polythene bottle and kept cool in a refrigerator at (4°C) for investigation.

Analytical methods: All chemicals were analytical reagent grade and used without further purification. Each analysis was performed in duplicate. Two different techniques were used for the analysis of metals: flame emission spectrophotometer (Sherwood 410 was used for the determination of the minerals (Na & K) and Perkin-Elmer 3100 atomic absorption, spectrophotometer for the determination of the trace elements (Ca, Co, Mg,

Cv etc.) following AOAC procedure (973.52;AOAC (Anon., 2000b). Chloride was estimated by volhards method. The pH was measured by Orion-710 pH meter (973.41, Anon., 2000b). Glucose content was analyzed by using Abbe- refractometer, Osmolarity through Osmometer (based on depression of freezing point) and TDS by Jenway - 4320 conductivity meter (Khan *et al*., 2003).

Results and Discussion

The main constituents of the food of animals and humans fall in six groups e.g., protein, carbohydrates, fats, minerals, vitamins and water. Complete chemical analysis was made on representative samples from the various components of the palm and the over all summary of the experimental results were tabulated in Table 1 and 2. The level of the minerals/trace metals depends on the amount of these minerals present in the soil, irrigation water and species of coconut cultivars. It was observed that the level of the minerals contain maximum (325.04 ± 2.38) mg/kg of the Na and the maximum sodium was (52.96 ± 0.300) found to be in the representative sample of the water (Hybrid) 11-12 month where lower concentration (8.33 ± 0.078) was detected in the representative sample of the 11-12 month meat of Hybrid variety.

Potassium is another important and essential element of both animal and plants and is present in huge quantity (60925.56 ± 34.95) mg/kg in 11-12 month meat of MYD variety. It was observed that the greater quantity of potassium (60925.56 ± 34.95) was analyzed in the representative meat sample of the MYD (11-12 month) and minimum (1221 ± 2.08) in the representative sample of the variety MYD (6-7) month meat A considerable amount of the Ca (4377.21 ± 291.634) mg/kg was found in SLT (6-7 month) water and minimum concentration (184.3 ± 1.55) mg/kg in representative sample of the Hybrid (6-7month) water. The Hybrid (6-7month) water contains (0.38 ± 0.023) mg/kg of Cobalt and its maximum percentage (30.23 ± 0.032) was found in SLT (11-12 month) meat where as minimum uptake was found in MYD and Hybrid varieties. The high concentration of Mg (824.48 ± 4.36) was observed in the MYD (11-12 month) meat and lower concentration (51.42 ± 0.35) mg/kg was found in SLT (6-7 month) water. The considerable amount of essential trace element caloric value (Cv) was found in hybrid (6-7 month) meat (12.57 ± 0.297) mg/kg as well as in water in SLT and MYD varieties where as maximum amount were observed in hybrid (11.21 ± 0.43) mg/kg of water (6-7 month). The consideration of Physio-chemical data about the moisture, volatile matters, Ash, TDS and pH are presented in Table 2.

Sugar and starch, (Carbohydrates) are complex organic substances consisting of carbon, hydrogen and oxygen in various combinations. Coconut development board (Net) noted that concentration of sugars in the nut water steadily increases from about 1.5% cent to about 5-5.5% in early months of maturation and then slowly falls reaching about 2% at the stage of the full maturity of the nut. In the early stages of maturity sugars are in the form of glucose and fructose (reducing sugars) and sucrose (non-reducing sugar) appears only in later stages which increases with the maturity while the reducing sugars fall. In the fully mature nut approximately 90% of the total sugars were sucrose. Coconut meat also contains less sugar and more protein than popular fruits such as bananas, apples and oranges, and it is relatively high in minerals such as irons, phosphorus and Zinc (Wikipedia, 2007).

Table 1. Level of minerals / trace metals in the coconut meat (Kernel) and coconut water nut analysis.

Variety	Na mg/kg^{-1}	K mg/kg^{-1}	Ca mg/kg^{-1}	Co mg/kg^{-1}	Mg mg/kg^{-1}	CV ms
	(6-7month) Meat					
SLT	325.04±2.38	59825.49±16.91	4377.21±3291.64	0.23±0.01	765.87±3.99	8.08±0.00
MYD	227.74±1.46	52615.07±29.48	202.66±3.11	0.12 ± 0.01	673.1± 2.95	7.28±0.10
Hybrid	10.73±0.04	56053.38±35.26	578.83±2.70	0.17 ± 0.00	623.92±267.6	12.57±0.29
	(11-12 month) Meat					
SLT	322.77±2.89	50210.16±52.21	239.73±0.88	0.23 ± 0.03	616.40±1.06	8.58±0.06
MYD	237.58±6.17	60925.56±34.95	375.58±2.19	0.16 ± 0.01	824.48±4.36	7.11±0.06
Hybrid	8.33±0.078	54197.75±31.28	470.92±2.95	0.14 ± 0.01	716.95±2.50	8.6±0.028
	(6-7 months) Water					
SLT	310.41 ± 2.90	1284.72±12.99	295.21±3.56	0.19 ± 0.01	51.42±0.35	9.09±0.21
MYD	291.05 ± 3.77	1221±2.08	476.33±5.20	0.173 ±0.00	172.33±2.40	8.02±0.01
Hybrid	158.66 ± 1.85	1269.33±5.78	184.3±1.55	0.38 ± 0.02	84.5±0.28	11.21±0.43
	(11-12 months) Water					
SLT	257.66±1.45	1239.1±2.16	206.66±2.96	0.12±0.01	122.49±0.51	8.81±0.09
MYD	339.69±0.89	1164.66±4.09	452.66±1.45	0.13±0.00	131.99±0.34	7.08±0.10
Hybrid	52.96±0.30	1249.76 ± 0.98	442.5±2.91	0.31±0.01	93.46±0.27	8.96±0.23

Mean with ± standard error of 3 replicates
SLT= Srilanka Tall, MYD: Malyan Yellow Dwarf, Hybrid (txt)
Unit Meat (Kernel) / Nut Water = mg/kg-^{1} & mg/L^{1}

Table 2. Physico-chemical analysis of coconut meat (Kernel) and Nut Water analysis.

Variety	Moisture%	Volatile matters%	Ash %	TDS g/L	pH
	(6-7month) Meat				
SLT	35.966±0.271	32.89±0.46	1.05±0.017	4.04±0.028	5.5±0.034
MYD	31.60±0.028	30.45±0.063	0.81±0.046	4.21±0.156	4.6±0.173
Hybrid	14.34±0.017	13.83±0.011	0.72±0.034	7.35±0.242	5.06±0.040
	(11-12 month) Meat				
SLT	61.72±0.213	59.53±0.554	0.85±0.034	4.99±0.023	4.46±0.086
MYD	37.61±0.052	35.39±0.138	1.28±0.011	3.00±0.115	4.43±0.184
Hybrid	55.80±0.404	52.66±0.047	0.86±0.034	5.23±0.086	4.16±0.086
	(6-7 months) Water				
SLT	36.01±0.260	33.59±0.011	1.11±0.040	4.84±0.034	4.32±0.023
MYD	31.79±0.098	30.38±0.080	1.37±0.011	4.31±0.011	4.80±0.057
Hybrid	14.02±0.034	13.98±0.017	0.79±0.017	7.62±0.017	4.88±0.017
	(11-12 months) Water				
SLT	61.96±0.086	59.01±0.057	0.91±0.032	1.31±0.029	0.87±0.030
MYD	37.47±0.046	35.22±0.052	1.37±0.046	4.21±0.011	4.42±0.034
Hybrid	56.5±0.115	53.12±0.093	0.87±0.028	5.17±0.086	4.14±0.231

Mean with ± standard error of 3 replicates
SLT= Srilanka Tall, MYD: Malyan Yellow Dwarf, Hybrid (txt).
Unit Meat (Kernel) / Nut Water = Percentage (%)

Ash percent when plant and animals are burnt, a mineral ash is left. Minerals occur in various quantities in different food and they are essential to life. Mineral function in the body in definite organic and inorganic combination and the usefulness of minerals in foods requires the correct combination, just as the coconut palm itself requires a correctly balanced mixture of mineral plant food for healthy growth and high productivity. The principal minerals are potash, phosphorus and magnesium, calcium essential to human nutrition is lacking in coconut meat.

Magnesium (Mg), component of chlorophyl, for balance of Ca and Mg is needed. The tender nut water contains various minerals of potash which is the major constituent, and its

concentration depends up on nature of potash manuring, pH, plays an important role for the induction of iron in to porphyrin as photophyrinine. The coconut water has a potential refreshing soft drinks, on the pH of the water is adjusted to 4.5 or less and the total soluble solids content from 8 to 10%, in order to up grade the flavors of ripe coconut water to the level of tender coconut water (Thampan, 1993). According to Southern, (1957) and Shivanandiah, (1970), Caloric value (CV) of coconut water has 17.4 per 100 gm.

Tender coconut water contains most of the minerals such as potassium, sodium, calcium, phosphorous, iron, copper, sulphur and chlorides. Among the minerals more than half is potassium, the concentration of which is markedly influenced by potash manuring. Tender coconut water being rich in potassium and other minerals plays a major role to increase the urinary output.

The percentage of essential amino acids e.g., arginine, alanine, cystine and serene in the protein of tender coconut water are higher than those in cow's milk (CDB, net). Same result was observed by Dolendo (1969), where the maximum protein content occurs in 10 month old nut. Santos *et al*., (1999) described fresh kernel as good source of protein, fat and carbohydrate. In fresh state it contains considerable amount of moisture and so freshly scraped coconut meat does not keep well as it is quickly attacked by bacteria and moulds. Green unripe coconuts contain meat which is soft and jelly like and can be removed from the shell with a spoon, the water obtained from such nuts is a very refreshing drink and the meat is delicious. The Change in weight of the fruit is highly dependent on any variation in the weight of kernel. The maximum weight of the meat in all varieties were noted, the tall varieties have maximum weight (1300g).

Dhillon & Dhillon (1984) observed that the amount of water was decreased with the age of the mature nuts. Maximum water was recorded in Dwarf varieties. Zinc deficiency is most common in calcareous and alkaline soils due to high pH, high CaCo3 contents and presence of minerals with high affinity for Zn. The protein in the edible white kernel of the coconut (mostly globulin) and amounting to 4.3%, is satisfactory as a food and will produce normal growth even when used as the only source of protien, provided the diet is complete in other respects. A comparison of nut water analysis with leaf analysis showed that water analysis was sensitive to Na and K, but not to Ca, or Mg. Nut water analysis was equally sensitive to P, S and Cl content (Jeganathan, 1992).

Thampan (1993) reported that fresh stale the kernel also contains good deals of moisture, which generally range between 42.0 and 46.0% kernel of coconut contains besides the mineral constituents, all three major food factors protein, fat and carbohydrate. The liquid endosperm of the tender nut coconut (Seven to eight month old) made a refreshing and agreeable drink, particularly during summer. The use of tender coconut water is recommended in cases of gastroenteritis and as a useful substitute for saline glucose in intravenous infusions.

Dolendo (1969), observed the variation in the relative weights of coconut shell, meat and water changes in the texture and composition of coconut meat at different stages of maturity. The maximum protein content occurs in 10-month old nuts. The drought markedly affects nut size and the volume of nut water and also by the reduced uptake of nutrients by the palm, the actual potash content of nut water. There is high correlation between in yield and the potash content of nut water. Nainanayake (2007) also noted that the drop in coconut production when soil water is deficient is mainly due to limitations at the stomatal level rather than at the non-stomatal (Biochemical) level of the assimilation process, especially in mild to moderate drought conditions.

While referring to data in this study, it can safely be summarized that out of three coconut varieties taken for observations, it was proved that immature nut water and meat is good for edible purpose. It is suggested that coconut palm if grown in coastal area of Pakistan to improve the health, environment and save the foreign exchange spent on the import of coconut, its oil and other products for daily use.

In the study, it was noted that meat (Kernel) and water changes in the texture and composition of coconut meat at different stages of maturity. The amature nut water is a very refreshing drink and amature meat (Kernel) is delicious. There is still an urgent need to undertake variety wise chemical analysis measures based on research in Pakistan.

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