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COMPARATIVE STUDY OF DIFFERENT SPECIES OF COCONUT WATERAND THEIR HEALTH BENEFITS

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Abstract

Background of the study: Phytochemicals and Phytohormones available in coconut water had expressed some remarkable anti-aging, anticancer and anticoagualant effects that contributed to the various health benefits. However, the species and maturation of such coconut water has limited information. Therefore,the aim of this study wasto ascertain the species of coconut, their specific phytochemical and phytohormones responsible for the health benefit.

Materials and Method: Fresh coconuts of different maturation stage: immature (120-200 days), mature (220-300 days) and over mature (320-380 days) both local and Hybridized were harvested in the coconut farm inOpume, OgbiaLocal Government of Bayelsa State. The following names were identified as the species of the coconut: the local and hybridized immature coconut as Malayan green dwarf, the local mature coconut as Fiji dwarf and hybridized mature and overmature coconut as macapuno and the local over mature coconut as local tall coconut.Phytochemical analysis ofdifferent maturation and type of coconut water were determined by different standard methods while phytohormones were analysed using high performance liquid chromatography UV detector (HPLC).

Results: Malayan green dwarf hybridized immature coconut was found to have highest mean content of phytochemical(74.42 ±132.75) and phytohormones(87.24 ±84.25).

Conclusion: Malayan green dwarf hybridized immature (HI) coconut waterphytochemical and phytohormoneshas been identified as potentcocconut water with great benefits more than other species and maturation stage.

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Introduction:-

The Arecaceae family's Cocos nucifera Linn is commonly known as coconut in English and is an important tropical fruit (Mandal and Mandal, 2011). It is a large palm with a height of 60 to 90 feet that can be found throughout the tropical and subtropical worlds. It is primarily located in Nigeria's coastal regions. The edible, domestic,

commercial, and industrial applications of the coconut are numerous (Campbell-Falck et al., 2000).The cellularization process in a coconut fruit does not take up the entire embryo sac cavity, but rather fills it with cytoplasmic-derived solution known as coconut water (Janick and Pall, 2008). The nutrients found in coconut water are carried symplasmically (via plasmodesmata, which connect the cytoplasms of adjacent cells) into the endosperm by the seed apoplasm (Nirankushet al., 2002). Coconut water is the aqueous portion of the coconut endosperm that contains 94% water (Janick and Pall, 2008).

Since its introduction to the scientific community in the 1940s, coconut water has been the subject of extensive research in human medicine. Naturally, it has many potential therapeutic properties and high nutritional values, and it is widely consumed around the world because it is refreshing (Janick and Pall 2008; Tan et al., 2014).

Coconut water (coconut liquid endosperm) contains many potential therapeutic properties, has high nutritional values and is commonly consumed globally because it is refreshing (Tan et al., 2014). Phytochemicals and Phytohormones available in coconut water had expressed some remarkable anti-aging, anticancer and anticoagualant effects that contributed to the various health benefits by previous findings (Rattan and Sodagam, 2005; **Onuoha** and Hallie, 2023;Onuoha et al., 2023). It was also discovered to possess a potential for boosting the human body antioxidant system, regulate hypertension and offer protection against myocardial infarction (Tan et al., 2014).

The presence of various bioactive phytochemical compounds, such as vitamins, amino acids, organic acids, enzymes, and phenolic acids, may contribute to these health benefits. Coconut water has also been linked to anti-inflammatory and immunostimulant properties (Yong et al., 2009; Prabhu et al., 2014; Christina et al., 2015; Geetha et al., 2016,). Furthermore, coconut water peptides have been proposed as potential anticancer agents (Prabhu et al., 2014; **Onuoha** and Hallie, 2023; Onuoha et al., 2023).

The aim of the study wasto ascertain the species of coconut, their specific phytochemical and phytohormones responsible for the health benefit.

Study area

Collection of coconut water

Fresh coconuts of different maturation stage: immature (120-200 days), mature (220-300 days) and over mature (320-380 days) both local and Hybridized were harvested fromthe coconut farm inOpume, Ogbia local government of Bayelsa State.

Plant scientist, Mr. BoluAyayi, of Plant biology department, University of Ilorin, Kwara State identified the coconut species on 26 August 2020 at about 11:00 am with code number: UILH/001/508/2020.The following names were identified as the species of the coconut: the local and hybridized immature coconut as Malayan dwarf, the local mature coconut as Fiji dwarf and hybridized mature and overmature coconut as macapuno and the local over mature coconut as local tall coconut.

Figure 1:- Identified species of local and Hybridized coconut with different maturation stage (HI=Hybridized Immature, HM= Hybridized Mature, HO= Hybridized Overmature. LI= Local Immature, LM= Local Mature, LO= Local Overmature).

The phytochemical wasanalysed using a standard method and phytohormones using High Performance Liquid Chromatography method.

Results:-

Table 1 showsQualitativeanalysis of coconut water with the following bioactive phytochemical substances: Alkaloids,Tanins, Saponins, Terpernoids, Coumarins, Steroids, Flavanoids, Phenolics and Glycosides.

Table 1:- Qualitative analysis of coconut water.

Samples	HI	HM	HO	LI	LM	LO
Saponin	+	+	+	+	+	+
Tannin	+	+	+	+	+	+
Phenolics	+	+	+	+	+	+
Flavonoids	+	+	+	+	+	+
Terpenoids	+	+	+	+	+	+
Triterpene	-	-	-	-	-	-
Coumarin	+	+	+	+	+	+
Glycosides	+	+	+	+	+	+
Steroids	+	+	+	+	+	+
Aikaloid+	+	+	+	+	+	
Phlobatanin	-	-	-	-	-	-
Anthocyanin	-	-	-	-	-	-
Amino acids	-	-	-	-	-	-

+= Detected, - = not detected.
HI=hybridized immature
HM= hybridized mature
HO= hybridized over mature
LI= local immature
LM= local mature
LO= local over mature.

Table 2showsquantitative Phytochemical analysis of coconut water in different maturation stage with the following mean value of bioactive substance; hybridized immature coconut water(HI)=74.42 ±132.75, hybridized mature coconut water (HM)= 24.73±30.00, hybridized over mature coconut water (HO)=25.56±45.62, local immature coconut water (LI)= 33.24±53.66, local mature coconut water (LM)= 26.11±31.69, local over mature coconut water (LO)=30.84±43.08.

Table 2:- Quantitative Phytochemicals (µg/100g) analysis of coconut water in different maturation stage.

Maturation	Alkaloids	Tanins	Saponins	Terpernoids	Coumarins	Steroids	Flavanoids	Phenolics	Glycosides	N	Mean±SD
HI	18.60	3.10	0.21	9.70	27.40	149.80	48.00	406.00	7.00	9	74.42±132.75
HM	8.20	9.00	0.18	5.50	20.50	89.40	29.40	56.90	3.50	9	24.73±30.00
HO	5.90	6.90	0.16	4.70	22.20	144.90	24.80	17.60	2.90	9	25.56±45.62
LI	9.00	9.10	0.18	5.00	26.60	170.90	32.30	42.70	3.40	9	33.24±53.66
LM	9.00	6.10	0.19	4.30	19.80	88.80	35.50	66.90	4.40	9	26.11±31.69
LO	7.50	7.10	0.17	4.60	21.80	127.60	29.90	74.90	4.00	9	30.84±43.08

HI=hybridized immature coconut water
HM= hybridized maturecoconut water
HO= hybridized over mature coconut water
LI= local immature coconut water
LM= local mature coconut water
LO= local over mature coconut water,

Table 3 shows Multiple comparisons ofphytochemical bioactive substances (µg/100g) in different maturation stages of coconut water such as hybridized immature coconut water (HI), hybridized mature coconut water (HM), hybridized over mature coconut water (HO), local immature coconut water (LI), local mature coconut water (LM), local over mature coconut water (LO) were done using least significant difference (LSD) test between means in ANOVA. LSD test showed that Malayan green dwarf Hybridized immature (HI) or tender coconut water was the cause of the Significant Difference in ANOVA (table 3). Therefore, the results from table 2 and table 3 indicate that hybridized immature coconut water (HI) identified asMalayan green dwarf with the following phytochemicals;Alkaloids, Tanins, Saponins, Terpernoids, Coumarins, Steroids, Flavanoids, Phenolics and Glycosides has the highest content of bioactive substance and will be considered as the best.

Table 3:- Multiple comparisons of phytochemical bioactive substances (µg/100g) in different maturation stages of coconut water.

Maturation stages	Mean Difference	Std. Error	p-value
HI-HM *	49.69*	23.11	0.038
HI-HO*	48.86*	23.11	0.041
HI-LI	41.18	23.11	0.082
HI-LM*	48.31*	23.11	0.043
HI-LO	43.58	23.11	0.067
HM-HO	-0.83	23.11	0.971
HM-LI	-8.51	23.11	0.715
HM-LM	-1.38	23.11	0.953
HM-LO	-6.11	23.11	0.793
HO-LI	-7.68	23.11	0.741
HO-LM	-0.55	23.11	0.981
HO-LO	-5.28	23.11	0.820
LI-LM	7.13	23.11	0.759
LI-LO	2.40	23.11	0.918
LM-LO	-4.73	23.11	0.839

*The mean difference is significant at the 0.05 level
HI=hybridized immature coconut water
HM= hybridized maturecoconut water
HO= hybridized over mature coconut water
LI= local immature coconut water
LM= local mature coconut water
LO= local over mature coconut water.

Table 4 shows Phytohormones (µg/100g) of the following bioactive substance: Cytokinins,Gibberellins, Ascorbic Acids, Apigenin, Rutin, Gallic Acids, p-cumaric, ferulic acid, salicylic acid analysis of coconut water in different maturation stage wereanalysed. The following were the mean values:hybridized immature coconut water (HI)=87.24 ±84.25; hybridized mature coconut water (HM)= 84.20±65.59, hybridized over mature coconut water (HO)=45.96±62.21, local immature coconut water (LI)= 23.711±36.13, local mature coconut water (LM)= 16.09±20.06, local over mature coconut water (LO)= 32.09±49.91.

Table 4:- Phytohormones (µg/100g) analysis of coconut water in different maturation stage.

Maturation	Cytokinins	Gibberellins	AA	Apigenin	Rutin	FA	N	Mean±SD
HI	121.20	191.30	168.20	362.70	39.70	6		87.24 ±84.25
HM	168.50	27.90	13.00	110.20	0.00	0.00		653.26±69.94
HO	98.40	38.10	0.00	0.00	0.00	0.00		622.75±40.07
LI	80.80	75.80	0.00	56.80	0.00	0.00		635.57±39.78
LM	38.40	54.80	0.00	19.00	25.80	6.80		624.13±20.28
LO	152.60	49.30	3.29	6.80	53.70	0.00		644.28±58.13

AA=Ascorbic Acid
FA=ferulic acid
SA= salicylic acid
HI=hybridized immature coconut water
HM= hybridized maturecoconut water
HO= hybridized over mature coconut water
LI= local immature coconut water
LM= local immature coconut water
LO= local over mature coconut water.

Table 5 shows Multiple comparisons of phytohormones analytes (µg/100g) in different maturation stages of coconut water: hybridized immature (HI), hybridized mature (HM), hybridized over mature (HO), local immature (LI), local mature (LM), local over mature (LO) were done using least significant difference (LSD) test between means in ANOVA. LSD test showed that Malayan green dwarf Hybridized immature (HI) coconut water was the cause of the Significant Difference in ANOVA (table 5). This indicate that hybridized immature coconut water (HI) identified as Malayan green dwarf with the following phytohormones Cytokinins, Gibberellins, Ascorbic Acid, Apigenin, Rutin, ferulic acid present had the highest content of bioactive substance and was considered as the best.

Table 5:- Multiple comparisons of phytohormone bioactive substance(µg/100g) in different maturation stages of coconut water.

Maturation stages	Mean Difference	Std. Error	p-value
HI-HM *	90.43*	37.17	0.035
HI-HO*	114.73*	37.17	0.012
HI-LI*	108.03*	37.17	0.016
HI-LM*	48.31*	37.17	0.043
HI-LO*	129.17*	37.17	0.006
HM-HO	24.30	37.17	0.528
HM-LI	17.60	37.17	0.646
HM-LM	38.73	37.17	0.322
HM-LO	1.43	37.17	0.970
HO-LI	-6.70	37.17	0.861
HO-LM	14.43	37.17	0.706

HO-LO	-22.8737.17	0.552
LI-LM	21.1337.17	0.582
LI-LO	-16.1737.17	0.673
LM-LO	-37.3037.17	0.339

*The mean difference is significant at the 0.05 level
HI=hybridized immature
HM= hybridized mature
HO= hybridized over mature
LI= local immature
LM= local immature
LO= local over mature.

Discussion:-

Inthis study, phytochemical and phytohormones of fresh coconut water of different maturation stages harvested in the coconut farm inOpume, Ogbia local government of Bayelsa State were analysed to ascertain the type and best maturation stage of coconut water that is most beneficial. Malayan green dwarf hybridized immature (HI) coconut waterwith the following phytochemical bioactive substances; Alkaloids,Tanins, Saponins, Terpernoids Coumarins, Steroids,Flavanoids, Phenolics, Glycosides andphytohormones; Cytokinins, Gibberellins, Ascorbic Acid, Apigenin, Rutin,Ferulic acid were observed to be more beneficial. This could be attributed to the fact that Malayan green dwarf hybridized immature (HI) coconut water had the highest content of phytochemicals and phytohormones. This is consistent with previous research on the quantification of cytokinins in coconut water from various maturation stages of Malaysian Coconut (Cocos nucifera L.) varieties, which found that Malayan green dwarf hybridized immature (HI) coconut water has the highest content of phytohormones (Lazim et al., 2015).

The presence of various bioactive phytochemical and phytohormones in coconut water has been widely researchedin human medicine. It naturally has many potential therapeutic properties, such as anti-aging, anti-carcinogenic, and anti-thrombotic effects, which have contributed to a variety of health benefits (Rattan and Sodagam, 2005; Tan et al., 2014,Onuohaet al., 2023**Onuoha**and Hallie, 2023).

The number of hydroxylic groups found in phenolic compounds determines their anticancer activity (Lee et al., 2000; Chenet al., 2015). The anticancer mechanism activities of alkaloids, saponins, and glycosides are by inhibiting cell proliferation by inducing cell cycle arrest at the G1 or G2/M phases (Yang et al.,2006; Tin et al., 2007; Jiang et al.,2010; Burgeiroet al., 2011). Triterpenoids inhibit the initiation and progression of carcinogenesis, as well as the differentiation and apoptosis of tumor cells (Ovesnáet al., 2004; Liu, 2005; Liby et al., 2007; Patlolla and Rao, 2012).

Cytokinins prevent platelet clots, which can cause heart attacks and strokes (Hsiao, 2003; Barciszewski, 2007).The predominant of coumarins are warfarin. Coagulation factors such as factors II, VII, IX, and X need carboxylation in their natural function. Therefore, the mechanism of coumarinsanticoagulant effect is through hindering vitamin K conversion cycle, which will lead to liver yielding incompletecarboxylated and decarboxylated proteins thereby decreasing the function of procoagulant (Malhotraet al.,1985).

There are three mechanisms by which flavonoids exert antioxidant effects: removing reactive oxygen species, inhibiting the formation of reactive oxygen species, resulting in the interaction of flavonoids with enzymes that regulate the formation of free radicals, and raising the shield of antioxidant systems, which leads to a reduction in cancerous cells (Sanchez et al., 2019).The radical molecule interacting with the antioxidant molecule producing balanced phenoxyl radicals is the antioxidativeactivity of ferulic acidmechanism. This mechanism shows that it will be difficult to create a complex interaction cascade that may result in the production of free radicals. Ferulic acids may release atoms to the radicals directly thereby becoming hydrogen donor hence, defending cellmembrane lipid acids from unwanted autoxidation processes (Kiewliczet al., 2015).

Contribution To Knowledge

This research work has contributed to knowledge in the following ways:

1. Malayan green dwarf hybridized immature (HI) coconut water phytochemical and phytohormones has been identified with potent anticancer properties as an alternative management of cancer.
2. Malayan green dwarf hybridized immature (HI) coconut water has been identified also with potent antioxidant and anticoagulant properties as an alternative managementof oxidative stress and coagulation disorder respectively.

Recommendations:-

1. Natural fruits should be promoted and legalised for the treatment of most of the terminal disease like cancer.
2. Additional research is needed to exploit, harvest, and isolate bioactive phytochemical and phytohormone compounds for novel anticancer, anticoagulant, and antioxidant therapy.

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