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Aluminium as a Limiting Factor for the Growth and Production of Coconut (*Cocos nucifera* L.) in Saurashtra Region

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Abstract

Cocos nucifera L. (Coconut), mainly grown in the coastal areas all over the world is considered as tree of life because of its varied uses. Using a scanning electron microscope and energy dispersive X-ray fluorescence (SEM-EDX), the present study reveals the elemental analysis of coconut grown in the Veraval region of Gir Somnath district in Saurashtra, Gujarat. According to the findings, the Indigenous (Desi) variety produces the most fruit and has a high potassium content. Other Veraval region types include Bona and Vanfer (dwarf kinds). One of the Bona kinds studied has limited growth due to excessive levels of aluminium and iron, whilst the other has optimal amounts of the needed nutrients and hence produces nice fruit. The aluminium level in the Vanfer variety also reduces the availability of essential elements like magnesium, which has an impact on fruit growth and yield. In addition, antimony, silicon, iron, and potassium have their effects discussed.

Key words: *Cocos nucifera* L., Elemental analysis, SEM-EDX, Growth, Production

Plants can produce high-quality fruits and yields if they have all of the nutrients they need to grow [1]. Plants require 16 elements, the most readily available of which are carbon, hydrogen, and oxygen, which can be found in soil, water, and the environment. Primary nutrients - nitrogen, phosphorus, potassium; Secondary nutrients -calcium, magnesium, sulphur; and Micronutrients - iron, zinc, manganese, copper, boron, molybdenum, and chlorine - are the remaining 13 essential elements, which are obtained either from soil (minerals and organic matter) or from organic or inorganic fertilizers. Increase or decrease in any nutrient concentration, on the other hand, have negative consequences on plant development and characteristics. Heavy metals are metals and metalloids that are toxic to both plants and animals from a biological standpoint. Non-essential elements, such as Hg, Pb, As, Cd, and Se, do not perform any physiological roles in plants, whereas essential elements, such as Cu, Co, Ni, Zn, Fe, Mo, and Mn, are required for normal plant development and metabolic operations. Plants become hazardous when the concentration of these critical elements exceeds the optimum need [2].

Due to the valuable components and nutrients inherent in Cocos nucifera L., often known as *Nariyal*, it has been used for a variety of uses ranging from household to health. Scanning electron microscopy (SEM) depicts the surface morphology and provides topographic data. EDS (Energy Dispersive X-Ray Analysis) is an X-ray technique that is used to determine the elemental makeup of materials [3-4]. Energy – dispersive X-ray spectroscopy (EDX) is a surface analytical technique in which an electron is excited from its inner shell and ejected, resulting in the development of an electron hole in the element's electronic structure. The energy is released in the form of an X-Ray as an electron from a higher-energy shell occupies the hole of the lower-energy shell. The amount of energy and number of X-rays released are measured, and the elements are identified. Veraval coconut types from the Saurashtra area are being studied.

MATERIALS AND METHODS

The investigation was performed using a scanning electron microscope with an EDX equipment. Leaf samples from the Bhalpara area of Saurashtra's Veraval region were collected for analysis [5]. The leaf was directly taken into the Kachchh University Chemistry Department's SEM-EDX apparatus (JEOL JSM-6510LV). Three kinds, Vanfer, Bona, and Indigenous, were chosen, and their SEM-EDX analysis is given below.

RESULTS AND DISCUSSION

Potassium is a prominent element of coconut, particularly in the plant's growing sections. It is essential for photosynthesis and aids in the increase of copra content in nuts. According to the SEM-EDX investigation (Fig 1, Fig 4, Graph 1, Graph 4), the Indegenous variety and Vanfer variety have 10.53 and 14.46 weight percent potassium, respectively, which improves the fruit quality and yield [6].

According to Biddappa *et al.* [7], the presence of heavy metals such as Al, Cd, Ba, Pb, and Cr (in roots) and their effects on leaf P, K, Ca, and Mg concentration in coconut palm showed

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reduced leaf P due to all heavy metal root feeding, particularly due to the Cd-P interaction, which reduced phosphate mobility. Cd, Al, and Ba lowered leaf K concentrations, but Pb, Cr, and Bi increased it. Leaf Ca concentrations were higher for Cd, Ba, and Cr, but lower for Al and Pb. Mg concentration dropped as Al concentration increased. In the vanfer variety without production (Fig 5, Graph 5), Al conc = 0.97, resulting in Mg = 0.36, but in the vanfer variety with production (Fig 4, Graph 4), Al = 0.93, resulting in Mg = 0. Al concentration = 0.32 and Mg = 041 in the Bona variety with production (Fig 2, Graph 2), while Al = 2.61 and Mg = 0.45 in the Bona variety without production (Fig 3, Graph 3).

Table 1 Table showing elemental composition of different varieties of *Cocos nucifera* L. using SEM-EDX analysis

Element	Indigenous (Desi) weight %	Bona with production weight %	Bona without production weight %	Vanfer with production weight %	Vanfer without production weight %
Na K	3.14	-	0.34	0.36	-
Mg K	0.80	6.24	0.45	-	0.36
Al K	0.38	0.32	2.61	0.93	0.97
Si K	0.59	0.82	4.29	3.32	2.23
P K	0.70	-	-	-	-
S K	0.45	-	-	-	0.28
Cl K	1.05	-	-	-	-
K K	10.53	-	0.63	14.46	-
Ca K	1.89	14.88	1.26	-	1.11
Sb L	-	10.42	-	-	-
I L	-	3.39	-	-	-
Fe L	-	-	15.51	0.25	-

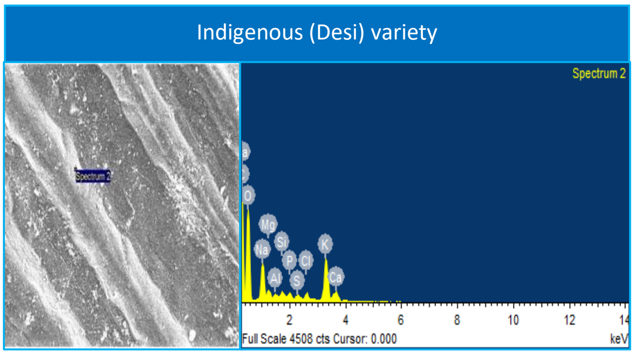
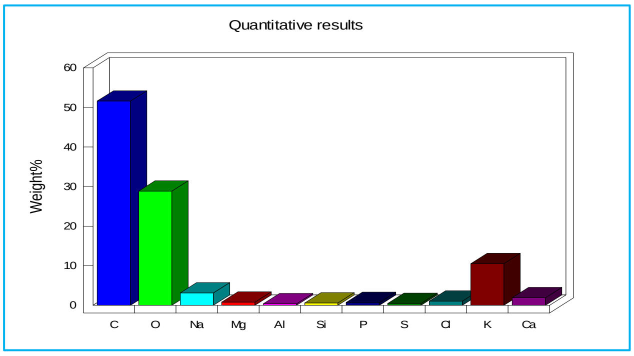


Fig 1 SEM-EDX analysis of indigenous (Desi) variety with production of *Cocos nucifera L.*



Graph 1 Elemental analysis of indigenous (Desi) variety of *Cocos nucifera L.*

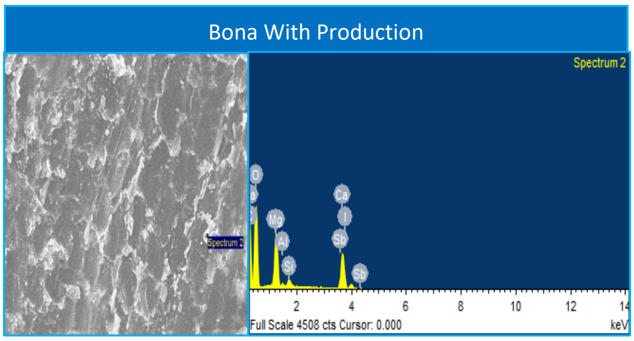
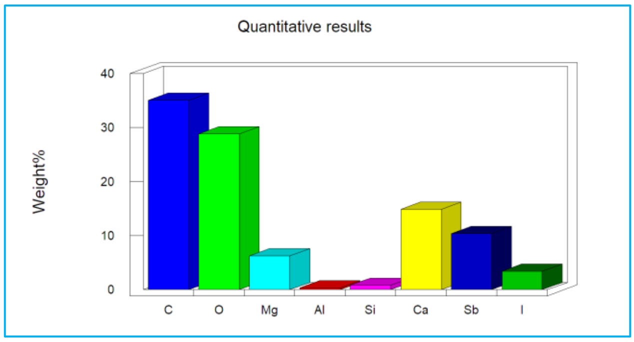


Fig 2 SEM-EDX analysis of dwarf (Bona Variety) with production of *Cocos nucifera L.*



Graph 2 SEM-EDX analysis of dwarf (Bona Variety) with production of *Cocos nucifera L.*

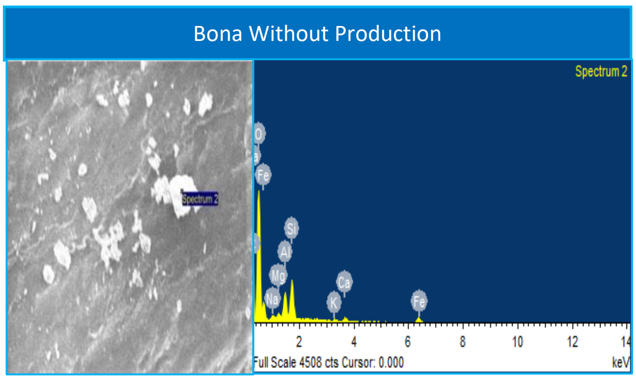
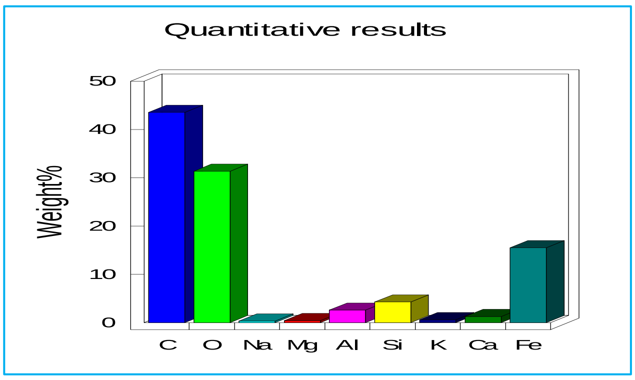


Fig 3 SEM-EDX analysis of dwarf (Bona Variety) without production of *Cocos nucifera L.*



Graph 3 SEM-EDX analysis of dwarf (Bona Variety) without production of *Cocos nucifera L.*

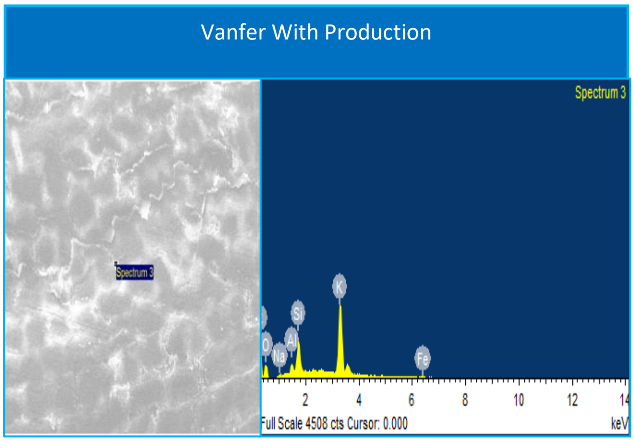
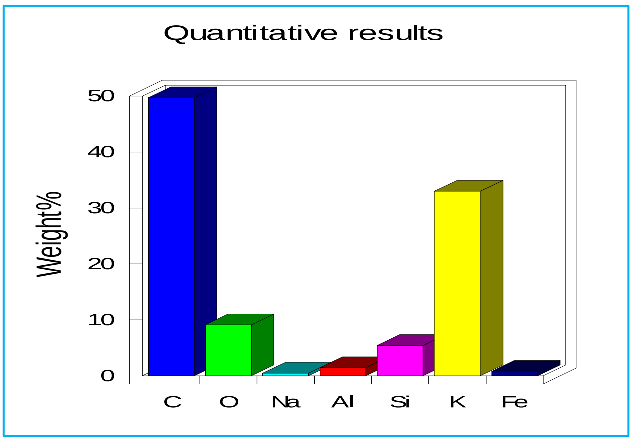


Fig 4 SEM-EDX analysis of dwarf (Vanfer Variety) with production of *Cocos nucifera* L.



Graph 4 SEM-EDX analysis of dwarf (Vanfer Variety) with production of *Cocos nucifera* L.

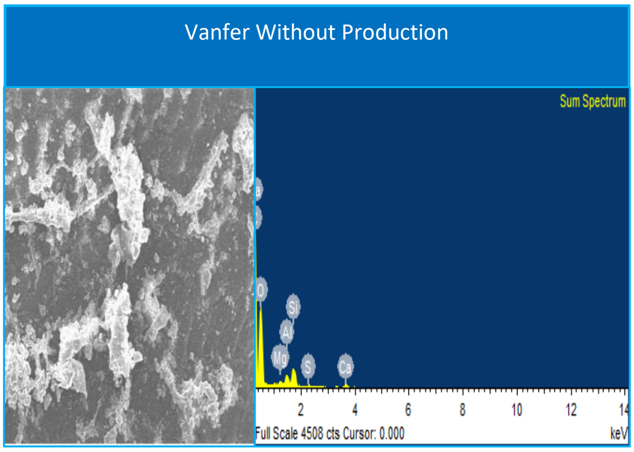
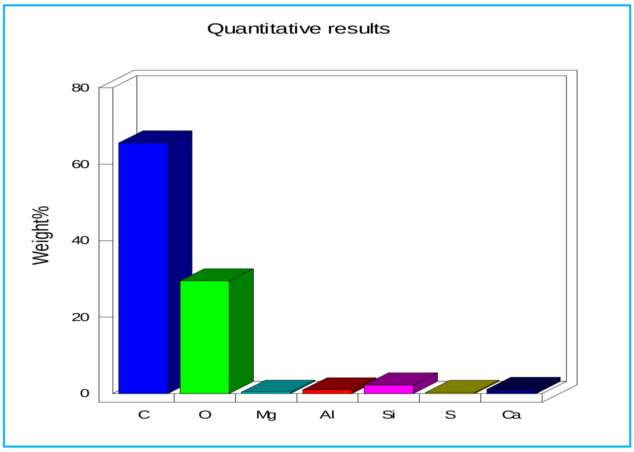


Fig 5 SEM-EDX analysis of dwarf (Vanfer Variety) without production of *Cocos nucifera* L.



Graph 5 SEM-EDX analysis of dwarf (Vanfer Variety) without production of *Cocos nucifera* L

Heavy metals such as bismuth, chromium, antimony, thallium, selenium, and other metalloids are poisonous, according to [8]. In this study, the Sb level in Bona leaves was determined to be 10.42 percent by weight. Antimony is a very uncommon metal. It is usually found in the form of sulphides and sulphur salts [9]. Antimony occurs naturally in the environment, according to Filella *et al*. [10]. It is also emitted in the atmosphere in the form of its trioxide as a result of various human activities such as coal burning or ore smelting. Antimony contamination occurs in metropolitan areas as a result of Sb abrasion from tyres, brakes, and vehicle exhaust [11]. Excess antimony causes circulatory system changes and diminishes life span in rats, according to a study conducted on rats [12], however excess antimony compounds consumed through food are eliminated in humans.

The availability and uptake of plant nutrients are influenced by soil pH. In soil with an acidic pH, iron is readily available. Photosynthesis necessitates the use of iron [13]. However, because manganese and iron are both necessary for plant growth, they compete for absorption, and an excess of one nutrient reduces the availability of the others. The Fe concentration of the Bona variety was determined to be 15.51 weight percent in this study, which could explain its low output. Excess iron in its ferrous form is absorbed by roots and then leaves, resulting in the generation of free radicals, which irreversibly damage cellular structure and membranes, as well as an increase in oxidative stress and a decrease in photosynthetic activity [14-16].

Silicon's benefits in controlling numerous biochemical and physiological functions in plants have been examined by various biologists. Changes in gene expression also aid in the development of organic defence chemicals [17-22]. Plants absorb silicon in the form of silicic acid when the pH is below 9. However, an excess of Silicon [23] may convert its shape to its most soluble forms, lowering its availability and raising the pH of the soil, negatively influencing plant development and nutritional balance. The total nutritional balance of silicon is maintained without impairing growth.

CONCLUSION

The current study demonstrates that the availability of each nutrient that affects plant growth is influenced by a variety of parameters such as soil pH, surrounding atmosphere, fertilizer accumulation, and so on. If all of the nutrients are present in the proper proportions, they are all useful. Excess nutrients, in any form or location on the plant, have negative consequences for overall productivity, fruit quality, leaf processes, and other physiological activities. Potassium is the most abundant mineral in coconut, and it aids photosynthesis, resulting in increased nut weight and leaf cell structures. SEM-EDX analysis reveals that Indigenous varieties produce the most fruit and have the highest potassium content. Because the Vanfer cultivar has a high aluminium concentration, it produces less fruits. The lack of fruit production in the Bona variety is owing to high aluminium levels, which lower magnesium levels and increase iron levels, both of which influence plant physiological activities. As a result of examining the effects of all micronutrients, appropriate steps can be taken or suggested to limit or increase the availability of these elements in the required amounts. A good quality and nutritious product can be made available to society through careful analysis.

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