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EFFECT OF PROCESSING AND FORTIFICATION ON MINERALS OF BAMBOO SHOOT AND FORTIFIED PRODUCTS

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ABSTRCT

Bamboo shoots are gaining worldwide importance as a health food being a rich repository of nutrients and health promoting bioactive compounds. The young shoots offer a diversity of micronutrients especially mineral elements, exceeding the profiles of several commonly used vegetables and have great potential to combat micronutrient deficiency or hidden hunger. Deficiency of mineral elements is the most common and widespread nutritional disorder globally and has noticeable effects on human health. Minerals are indispensable due to their diverse functions in body metabolism and are critical for many metabolic processes by serving as essential co-factors for a number of enzymes. Bamboo shoots are a good source of macro and micro mineral elements. Apart from being an excellent source of food, bamboo is used in traditional medicines in many Asian countries. Modern research has supported most of the medicinal properties such as antioxidant, antidiabetic, antimicrobial, antitumor and prevention of cardiovascular and neurological disorders. Due to its nutritional and medicinal properties, bamboo shoot is an ideal bioresource for the development of novel functional foods and nutraceuticals. The present paper discusses mineral elements in fresh and processed bamboo shoots and shoot fortified products and the prospects of using bamboo shoots for food fortification.

Keywords: Worldwide, Micronutrients, Mineral, Metabolism, Bioresource, Nutraceuticals

1. INTRODUCTION

Young Bamboo shoots are a good source of bioactive compounds that are beneficial to one's health. Fermentation significantly lowered oxalate levels, improving mineral bioavailability because they have such a wide variety of functions and potentials in the body's metabolism and homeostasis, minerals, which make up the largest category of micronutrients, are absolutely necessary for healthy body development. They are necessary for the preservation of the hormonal and regulatory activities of our body, as well as the proper structural and physiological growth of our body, and they play a crucial part in the development of our muscles and bones. Calcium, phosphorus, sodium, chlorine, potassium, magnesium, nickel, and sculpture are all examples of minerals that belong to the category of macro-minerals.Macromineralsare defined as being needed in bigger amounts. Trace quantities of certain elements, such as cobalt, copper, iodine, iron, manganese, molybdenum, selenium, zinc, chromium, and fluorine, are necessary for living things to function properly. These elements are collectively referred to as trace minerals. Experiments conducted by scientists have made it more clear that eating a diet that is high in nutrients that are good for one's health may aid in the prevention and management of a variety of illnesses, including diabetes, cardiovas culardisorders, stroke, and cancer (Tolonen, 1990). Because plants are the primary source of food, one of the most significant difficulties facing agriculture today, in addition to increasing the amount of food that can be produced, is to ensure that people have access to practically all of the nutrients they need to be healthy Martinez-Ballesta et al., 2010). It is of the highest significance to find andincor porate food sources that are rich repositories of micronutrients in addition to being a balanced source of energy and nutritious nutrients in order to successfully counteract the health hazards that are caused by mineral element shortages .Bamboo is one of those plants that stands out due to the remarkable health ad vantages it offers. Plant-based meals are vital sources of critical minerals, nutrients, and bioactive substances that enhance health (Nirmala et al., 2011, 2018; Singhal et al., 2013). In addition to serving as a source of nutrition for both humans and animals, bamboo shoots are involved in a number of important bioactivities.

2. OBJECTIVE OF STUDY

- Bamboo shoots are a rich source of macro and micro mineral elements.
- Young shoots are an ideal resource for functional foods and nutraceuticals.
- Shoots and shoot fortified products can help in combating micronutrient deficiency

POTASSIUM-Potassium, which is a necessary component for a wide variety of cellular processes, can be found in the majority of meals and is mostly eliminated via the kidneys. A lack of potassium may cause abnormalities in the function of the neurons, muscles, heart, blood vessels, digestive tract, and kidneys. When aperson's potassium levels drop below 3.6 mmol/L, a condition known ashypokalemia may develop. Hypokalemia is a severe form of potassium insufficiency (Weiner et al., 2018). Although it is common knowledge that potassium is beneficial to one's health, it is difficult to

determine the ideal doses of this mineral, and as a result, its applications have not been widely explored beyond the simple recommendation that one consume potassium-rich foods like potatoes, bananas, and oranges. Dainelli et al. (2017) conducted a study to determine the long-term cost-effectiveness of eating milk powder that has been supplemented with potassium in China with the goal of lowering systolic blood pressure (SBP) and preventing cardiovascular events. For the purpose of the research, an incremental cost-effectiveness ratio (ICER) was used. This ratio took into account the financial expenses connected with cardiovascular events, as well as the impact on health utilities and the number of lost working days. In addition to lowering blood pressure and lowering the risk of cardiovascular disease, the intake of a milk powder that had been enriched with potassium on a regular basis led to cost savings owing to the reduction of unnecessary medical procedures.

PHOSPHORUS-The phosphorus content that was estimated in this experiment was in the range of 488-590.67 mg/100g dr. wt. in freeze-dried and oven-dried powder of unprocessed and processed forms of D. hamiltonii shoot. This estimate was based on the dry weight of the powder. According to Saini et al. (2017), the amount of phosphorus found in the fresh shoot of B. balcooa and B. bamboo ranges from 560-750 mg/100g dry weight, which agrees with the findings of the current study, in which the amount of phosphorus was found to be 28.12 mg/100g dry weight.203The powder made from oven-dried untreated shoots had the highest

Concentration of content, while the powder made from soaking shoots that had been freeze-dried had the lowest concentration. The findings suggest that the phosphorus concentration dropped when the shoot samples were boiled and soaked, and the fortified products exhibited the same impact. During the preparation of fresh bamboo shoots of several edible species, similar findings and conclusions were also discovered (Pandey and Ojha, 2014; Hailu and Addis, 2016; Saini et al., 2017). In comparison to freeze-dried and oven-dried powder of shoot formulation, the content of the product that was fortified with fresh weight shoot samples was found to be the lowest. On the other hand, in the case of biscuits, the content was found to be the lowest and most stable in all of the products that were fortified with fresh weight of unprocessed, boiled, and soaked shoots. When compared to the control biscuit, the phosphorus content of the biscuit that had been fortified with freeze-dried and oven-dried shot powder was found to be much greater than that of the control biscuit. However, the phosphorus fortification was found to be significantly greater in virtually all of the formulations of namkeen and noodle when contrasted with the control product, which had 148 mg/100g dry weight of phosphorus and 146.67 mg/100g dry weight of phosphorus correspondingly.

SULPHUR-Compounds containing sulphur have been utilised for the treatment of skin ailments, rheumatic problems, and parasite infestations in China, India, Egypt, and Greece since ancient times. The consumption of methionine (Met), an essential amino acid that may be found in both plant and animal proteins, is the primary source of this element, which occupies the seventh spot on the list of elements whose concentrations can be measured in the human body. Sulfur functions as acofactor of various enzymes that are involved in the control of oxidative 204processes. It also plays a vital part in the creation of a very large number of crucial metabolic intermediates, such as glutathione. Sulfur's primary function is to regulate oxidative activities. Sulfur deficiency in the diet dramatically increases the likelihood of developing cardiovascular disease and having a stroke (Ingenbleek and Kimura, 2013). Ozbek and Baysal (2015) devised a technique that makes use of a high-resolution continuous source flame atomic absorption spectrometer in conjunction with an air/acetylene flame in order to calculate the levels of sulphur that are present in various meals.

SODIUM-Sodium is an essential mineral component for regulating the amount of water in the body, which in turn supports proper nerve and muscle function and contributes to the formation of extracellular electrolytes (Kronzucker et al., 2013).In the current investigation, the freeze-dried powder of shoot had a sodium content of 11 mg/100g dry weight, whereas the oven-dried powder had a sodium content of 20 mg/100g dry weight. In addition, Saini et al. (2017) reported the salt concentration of the fresh shoot of B. balcooa and B. bambos, which was found to be 20 mg/100g dry weight, which is comparable to the data presented here.Waikhom et al. (2013) and Christian et al. both reported a range that was quite comparable to this one (2015). Fortified biscuits and namkeen were found to havens extremely high rise in their content after being given the nutritional supplement. The rise in salt concentration is very certainly attributable to the components that went into the production of biscuits and namkeen. Also, when compared to the salt level that was recorded for bamboo shoot reinforced nuggets, papads, and pickles, it was determined that the content was an exceedingly low amount (Pandey et al., 2012).

CHLORINE-Along with sodium and potassium, chlorine is a naturally occurring non-metallic macro mineral element that plays an important part in the human body's ability to operate properly. These roles include the management of osmotic pressure and 206 the maintenance of acid-base balance (Welz et al., 2009). The recommended daily intake of chlorine for an adult between the ages of 19 and 50 is 2300 mg.This ensures that the body is able to operate properly (Otten et al., 2006). Table salt, seafood, milk, eggs, and meat are the primary sources of chlorine in the Average human diet (Mahan and Escott-stump, 2003). Even if an excessive intake of chlorine may induce metabolic diseases, metabolic

alkalosis can also be caused by a lack of chlorine, which calls for a healthy equilibrium and quality management (Whitney et al., 2001). In the current study, the concentration of chlorine ranged from 616.67-882.67 mg/100g dr. wt. in a variety of unprocessed and processed forms of freeze-dried and oven-dried powder of shoot. This was determined by measuring the dry weight of the powder. Boiling and soaking both resulted in a reduction in the amount of the substance, which is corroborated bythe earlier research conducted by Saini and colleagues (2017). In the namkeen products, the chlorine level was exceptionally highest with 1742.67 mg/100g dr. wt.in namkeen fortified with boiling shoot sample. The chlorine content was greater in the fortified biscuit and noodle when compared to the control. During the process of deep frying the product, sodium and chlorine from the salt component that is a part of the formulation may break down and be released into the atmosphere. This results in an unusually high level of chlorine in the namkeen.

MAGNESIUM- After calcium, potassium, and sodium, magnesium is the fourth most abundant mineral found in the human body. It plays an important role as a cofactor in more than 300 different metabolic events that take place in the body. It may be found in many foods in its natural state and is also sold separately as a nutritional supplement. Because magnesium dependent kinases, which are an essential part of signal transduction, are responsible for the activation of thirty percent of the body's functioning proteins, it is recognized as a chronic regulator in the biological world (Ismail et al., 2016). Magnesium also plays a critical role in maintaining normal nerve and muscle function, neuromuscular conduction, muscular contraction, normal blood pressure, bone integrity, and glucose and insulin 207 metabolisms. Magnesium deficiency has been linked to a number of chronic diseases such as Alzheimer's disease, stroke, cardiovascular disease, and diabetes. Magnesium also plays a critical role in maintaining normal nerve and muscle function (Volpe, 2013; Di Nicolantonio et al., 2018). Latent magnesium insufficiency may develop from chronic insufficient intake of magnesium over an extended period of time.

CALCIUM- Calcium is the mineral that is found in the greatest abundance in the human body and is essential for maintaining optimum health. It is most typically connected with the production and metabolism of bone and more than 99 percent of the body's total calcium is found as calcium hydroxyapatite in bones and teeth,

208 providing the body with the strength it need to function properly. In addition to this, it plays a significant part in the regulation of a wide range of important bodily processes, such as nerve transmission. It also helps the body clot its blood, regulates the transport of waste products and nutrients across cell membranes, and controls the enzymes that are responsible for muscle contraction, digestion of fat, and metabolic processes (Johnson-Down et al., 2003). Research into the effects that different diets, foods, and minerals have on bone health has received great deal of attention over the last two decades (Whiting et al., 2016). Calcium and vitamin D are extensively utilized as dietary fortificants and are highly recommended as public health interventions for the prevention of enhanced bone health. However, milk and dairy-related products are the most often fortified foods. Orange juice, other drinks, and cereals that are already prepared for consumption that have been fortified are now highly fashionable. Calcium carbonate and calcium citrate are the two most prevalent types of calcium that are taken in supplement form.

SILICONE-Although it has been fully recorded as an important trace element, bamboo has the greatest silica concentration, and various biochemical and clinical studies have proved the benefits of silicon on human health impact (Rawat et al., 2016).Even though silicon is found in all of the body's tissues, the largest amounts of silicon are found in bone and other connective tissues, such as the skin, hair, and nails. Silicon is also found in all of the body's organs. Silicon has been shown in a number of different trials to play an important part in the process of bone formation and maintenance. Silicon has been shown to increase the quality of bone matrix and to accelerate bone mineralization. It has been shown that supplementation with silicon; both in animals and in people, increases bone mineral density and improve bone strength (Price et al., 2013). There have been reports of improvements in bone mineral density and bone strength in quail, broiler chickens, and rainbow trout that received silicon supplementation (Kucukbay et al., 2008). According to research conducted on mice, it also helps the body better incorporate calcium into bone tissue. Silicon may be obtained by the consumption of foods such as whole grains, cereals, beer, and some vegetables like green beans. Although it is widely used in the food industry, the intestinal absorption of silicon in the form of silica, also known as silicon dioxide (SiO2), is rather low. In the current investigation, the silicon content was analyzed various forms of freeze-dried and oven-dried powder of D. Hamiltonian shoot. The results showed that the silicon content was within the range of 127.67-189.00mg/100g dr. wt., with the highest content being observed in freeze-dried powder of unprocessed shoot.

ZINC-Zinc deficiency is a worldwide nutritional concern, especially among children and women living in low- and middle-income nations where the diets are mostly grain based (Shah et al., 2016). Foods based on cereal are particularly high in both dietary fiber and phytates, two compounds that inhibit the intestinal absorption of zinc. Zinc is a trace element that is an essential component of manymetalloenzymes that play important roles in fundamental aspects of metabolism in the human body, including the reproductive, neurologic, immune, dermatologic, and gastrointestinal

systems. Zinc also plays a role in the production of some hormones. This vitamin may be found in a broad variety of meals; however, the foods that have the greatest quantities of it are meat, fish, nuts, seeds, legumes, and cereals made with whole grains. Zinc deficiency in childhood can cause cognitive impairment and behavioral issues (Gogia and Sachdev, 2012), hair loss, inflammation of the eyelids and conjunctiva (Imdad, 2011), growth retardation (Imdad, 2011), and can affect fertility, reproductive performance, and work capacity in adults. Zinc deficiency in childhood can also cause growth retardation (Shah et al., 2013). Zinc fortification of staple foods may prove to be an efficient method for reducing the risk of zinc deficiency and enhancing the health outcomes that are associated to zinc.

IRON-More than a quarter of the world's population is affected by iron deficiency, which is the leading cause of anemia in every region of the globe. For many years, one of the most prevalent methods that has been used to fight iron deficiency has-been the practice of adding iron to meals. At the present time, cereal flours, particularly wheat and maize flour, are the most popular carriers for iron fortification to reach the general population (Uauy et al., 2002). Fortification of wheat flour with iron in Jordan led to a considerable reduction in the prevalence212of iron deficiency anemia in children, which went from 26% to 13.7% in that country (Dwyer et al., 2015). Iron fortification is not as effective as fortification programmes with iodine and vitamin A due to critical technical barriers such asthe bioavailability of iron, selection of the vehicle (food/matrix), the balance of inhibitors and enhancers, and total iron intake. However, iodine and vitamin A fortification programmes have been shown to be successful. The best options are ferrous sulphate, fumarate, and electrolytic iron; however, this is contingent on the food matrix, packaging, and storage conditions being compatible with shelf life. The use of condiments and sauces as vehicles for iron fortification offers a number of benefits due to the fact that they are traditionally included in the daily diet of the majority of countries, are widely consumed, are able to reach vulnerable populations, and can be added to a variety of foods as well as combined with iron-fortified staple foods.

MANGANESE-Manganese is an essential trace mineral that plays an important role in the Metabolism of amino acids, lipids, and carbohydrates, as well as the creation of proteoglycans throughout the process of bone formation. It plays an important role in the metabolism of carbohydrates, fats, and proteins and is a component ofmetalloenzymes such as superoxide dismutase, arginase, and pyruvatecar boxylase. In terms of biology, it is a component of many enzyme systems that are involved in the breakdown of these macromolecules (Haugen et al., 2019). Awide variety of foods, including nuts, legumes, seeds, tea, whole grains, leafy green vegetables, seafood, and meat, all contain manganese in varying amounts. It plays an important role in the creation of cellular energy, reproduction, and the synthesis of connective tissue, bone, blood clotting factors, and sex hormones, as well as bolstering the immune system and maintaining a healthy blood sugar level (Isong et al., 2019). The appropriate intake (AI) for manganese in adults is determined to be 1.8 milligrams per day for women and 2.3 milligrams per day for men. In the present study, the amount of manganese that was found in various unprocessed and processed shoots of freeze-dried and oven-dried powder of D. Hamiltonian shoot varied between 5.20 mg/100g dr. wt. and 20.20mg/100g dr. wt. When compared to the oven-dried shoots, the content was found to be at its highest in the freeze-dried samples of the shoots.

COPPER-Copper, a trace metal that is important to the body serves as a cofactor for a large number of redox enzymes and is involved in a wide variety of biological activities, such as the production of neuropeptides, immunological function, and antioxidant defence (Bost et al., 2016). Copper deficiency or insufficiency may contribute to many of the risks or signs of ischemic heart disease (IHD), and low dietary copper intake lowers immune response. Ischemic heart disease (IHD) mischaracterized by blood clots that form in the coronary arteries (DiNicolantonio etal. 2018). However, research has shown that the majority of individuals do not even ingest the required daily requirement of 0.9 mg of copper per day. The optimal intake of copper is 2.6 milligrams per day. In comparison to iron and zinc, copper is not as often employed in the process of fortifying food. Copper gluconate and copper sulphate are the two primary chemicals that are recommended for fortification purposes (Rosado, 2003). Copper sulphate is the more frequent of the two compounds since it is not only highly reactive but also stable and less costly. Copper intake should be between 1.2 and 3.0 milli grammes per kilogram me of wheat for basic meals.

NICKEL-In higher organisms belonging to the animal and plant kingdoms, nickel is a component of the enzyme urease that is necessary for the breakdown of urea into ammonia. Urease is involved in the production of ammonia via the breakdown of urea. According to the results of certain studies, applying nickel salts to the seeds of numerous different species causes them to germinate more quickly. There is a lack of consensus over whether or not nickel is important for humans from a dietary or metabolic standpoint (Cunningham, 2017). It is found in almost every part of the environment, and as a result, it may be found in the foods of both plant and animal origin that are ingested by people (Frausto and Williams, 2001). Ingesting nickel via one's diet and ingesting it through one's use of drinking water are the two most common ways that humans are exposed to nickel. Nickel is advised to be consumed between between 0.1 and 0.3 milligram’s on a daily basis as part of a healthy diet (De-Browere et al., 2012).Scancar et al. (2013) used inductively

coupled plasma mass spectrometry (ICP-MS) to determine the total nickel concentration in a variety of food products available in Slovenia, including yoghurt and tofu, dark and milk chocolates, and hazel nuts. This was accomplished by first using microwaves to aid in the digestion of sample materials. According to the findings of the research, having 200 grammes of soy yoghurt or soy tofu added around 1200 or 400 milligrams of nickel, respectively. On the other hand, eating 100 grammes of chocolate or 100 grammes of hazelnuts contributed approximately 500 milligrams of nickel. Because large amounts of nickel may have a negative impact on one's health, it is essential to ave an understanding of the metal's bioavailability.

3. RESEARCH METHOLOGY

The study aims to evaluate the effect of processing and fortification on the mineral composition of bamboo shoots and fortified products. Various processing methods were applied to analyze their impact on mineral retention, and fortification techniques were employed to enhance the nutritional quality.

Selection of Raw Materials: - Fresh bamboo shoots were collected from local sources and cleaned to remove dirt and outer sheaths. The samples were standardized based on size, maturity, and moisture content before processing.

Processing Methods Applied: - Different processing techniques were used to assess their impact on the mineral content of bamboo shoots:

Boiling:-Shoots were boiled in water at 100°C for 15, 30, and 45 minutes to evaluate mineral leaching. The water was discarded after boiling, and the samples were dried for further analysis.

Blanching: - Bamboo shoots were blanched in hot water at 80°C for 5 minutes to assess mineral retention. Samples were cooled and dried before analysis.

Fermentation: - Shoots were fermented using Lactic Acid Bacteria (LAB) at room temperature for 5–7 days. Fermented samples were dried and stored before testing.

Drying Methods:-Sun-drying: Bamboo shoots were dried under direct sunlight for 5–7 days.

Oven-drying: Samples were dried at 60°C for 8 hours.

Fortification Techniques: - To improve the mineral content, bamboo shoots were fortified with key minerals:

Iron Fortification:-Ferrous sulfate and iron salts were added to bamboo flour at different concentrations (5 mg, 10 mg, and 15 mg per 100 g).

Calcium Fortification: -Calcium carbonate and calcium lactate were used to fortify bamboo-based products.

Multi-Mineral Fortification:-A combination of iron, calcium, and zinc was added to enhance overall nutritional quality.

Mineral Analysis:- Mineral composition was analyzed using standard laboratory methods:

Atomic Absorption Spectroscopy (AAS):-Used to measure iron, calcium, magnesium, and zinc levels.

Inductively Coupled Plasma Mass Spectrometry (ICP-MS):-Used for trace mineral analysis to detect variations in mineral content after processing and fortification.

Flame Photometry:-Used for sodium and potassium determination.

Statistical Analysis:- Data was analyzed using ANOVA (Analysis of Variance) to determine significant differences in mineral retention across processing methods and fortification levels.

Sensory and Stability Analysis:-Sensory evaluation was conducted using a trained panel to assess the acceptability of fortified bamboo products. Shelf-life stability tests were performed by analyzing mineral retention over time under different storage conditions.

4. RESULT & DUSCESSION

This section presents the findings on the effect of processing and fortification on the mineral composition of bamboo shoots and fortified products. The results highlight changes in mineral content due to different processing techniques and the effectiveness of fortification in enhancing nutritional value.

Effect of Processing on Mineral Content

Iron (Fe) Content:-Boiling led to a significant reduction in iron content (~30-40%) due to leaching into the cooking water. Blanching preserved more iron compared to boiling, retaining ~85% of the original iron content. Fermentation slightly increased iron bioavailability due to the breakdown of anti-nutritional factors such as phytic acid, which inhibit iron absorption. Sun-drying and oven-drying caused minimal changes in iron levels, making them suitable for preserving mineral content.

Calcium (Ca) Content:-Boiling resulted in a 25-35% loss of calcium due to solubilization in water. Fermentation improved calcium bioavailability by reducing oxalates, which bind calcium and reduce its absorption. Oven-drying and sun-drying retained most of the calcium (~90%), making them preferable for calcium preservation.

Zinc (Zn) and Magnesium (Mg) Content:-Boiling and blanching led to moderate zinc losses (~20%), while fermentation enhanced zinc bioavailability due to microbial breakdown of anti-nutrients. Magnesium losses were lower (~10-15%) across all processing methods, indicating relative stability of this mineral.

Reduction of Anti-Nutritional Factors:- Cyanogenic glycosides reduced by 66% after boiling, improving food safety. Fermentation significantly lowered oxalate content (~50-60%), enhancing calcium and iron absorption. Drying methods retained higher anti-nutritional factors, suggesting the need for additional pre-processing steps.

Effect of Fortification on Mineral Content

Iron Fortification:-Fortified bamboo products showed a 2.5x increase in iron content, improving potential benefits for preventing anemia. The iron remained stable during processing, making fortification effective in maintaining nutritional value. Fermentation enhanced iron absorption by reducing anti-nutritional factors like phytic acid.

Calcium Fortification:-Fortified products had a 67% increase in calcium levels, significantly improving their nutritional quality. Calcium carbonate and calcium lactate showed high retention rates, with minimal losses during processing.

Multi-Mineral Fortification:-Simultaneous fortification with iron, calcium, and zinc led to substantial improvements in the mineral profile. Minerals remained stable during storage, ensuring long-term nutritional benefits.

5. DUSCESSION

Processing methods affect mineral retention, with boiling causing the highest losses and drying preserving most minerals. Fermentation improves mineral bioavailability by reducing anti-nutrients, making it a preferable processing method. Fortification effectively enhances mineral content, particularly iron and calcium, making bamboo-based products more nutritionally valuable. A combination of fermentation and multi-nutrient fortification provides the best results in terms of mineral retention, bioavailability, and food safety. Modern research has supported most of the medicinal properties such as antioxidant, antidiabetic, antimicrobial, antitumor and prevention of cardiovascular and neurological disorders.

6. CONCLUSION

The study on the effect of processing and fortification on the mineral composition of bamboo shoots and fortified products highlights the significant impact of different processing techniques on mineral retention and bioavailability. It also demonstrates the effectiveness of fortification in enhancing the nutritional quality of bamboo-based food products. Due to its nutritional and medicinal properties, bamboo shoot is an ideal bioresource for the development of novel functional foods and nutraceuticals. Bamboo shoot being rich in macro and micro minerals has the potential to prevent malnutrition and combat hidden hunger which is presently a matter of great concern. Although required in small quantities, mineral elements are indispensable to the maintenance of life. Bamboo shoots and shoot fortified food products are a good source of potassium, manganese, iron, calcium, chromium, zinc, selenium and phosphorus. The present paper discusses mineral elements in fresh and processed bamboo shoots and shoot fortified products and the prospects of using bamboo shoots for food fortification.

Key Findings

Processing Effects on Minerals:-Boiling and blanching cause mineral losses, with iron and calcium showing the highest reductions due to leaching. Fermentation improves mineral bioavailability by reducing anti-nutritional factors like phytic acid and oxalates, which inhibit mineral absorption. Drying methods (sun-drying and oven-drying) effectively retain minerals, making them preferable for nutrient preservation.

Fortification Enhances Nutrient Content:-Iron fortification increases iron levels by 2.5 times, making bamboo-based products more suitable for addressing iron deficiency. Calcium fortification boosts calcium content by 67%, improving its potential as a plant-based calcium source.Multi-mineral fortification (iron, calcium, and zinc) significantly improves the overall mineral profile, ensuring a more balanced and nutritious product.

Processing and Fortification Combination:-A combination of fermentation and fortification yields the best results by enhancing both mineral content and bioavailability. Fortification helps compensate for mineral losses due to processing, ensuring that the final product remains nutritionally rich.

Recommendations:-Fermentation should be incorporated into bamboo is processing to enhance mineral bioavailability while maintaining food safety. Fortification is an effective strategy to improve bamboo-based products, especially for

populations at risk of mineral deficiencies. Future research should focus on optimizing fortification levels and assessing consumer acceptability for large-scale production.

Final Remark: - This study confirms that processing methods influence mineral retention, but fortification effectively enhances nutritional value. The findings suggest that a well-balanced approach combining appropriate processing techniques with mineral fortification can improve the nutritional and functional properties of bamboo shoot-based foods, making them a valuable dietary option.

7. REFFRENCES

[1] Dainelli, L., Xu, T., Li, M., Zimmermann, D., Fang, H., Wu, Y. and Detzel, P. 2017. Cost effectiveness of milk powder fortified with potassium to decrease blood pressure and prevent cardiovascular events among the adult population in China: a Markov model. British Medical Journal, 7(9): e017136.

[2] De Brouwere, K., Buekers, J., Cornelis, C., Schlekat, C.E. and Oller, A.R. 2012. Assessment of indirect human exposure to environmental sources of nickel: oral exposure and risk characterization for systemic effects. Science of the Total Environment, 419: 25-36.

[3] DiNicolantonio, J.J., Mangan, D. and O'Keefe, J.H. 2018. Copper deficiency may be a leading cause of ischemic heart disease. Open Heart, 5(2): e000784.

[4] Dwyer, J.T., Wiemer, K.L., Dary, O., Keen, C.L., King, J.C., Miller, K.B., Philbert, M.A., Tarasuk, V., Taylor, C.L., Gaine, P.C. and Jarvis, A.B. 2015. Fortification and health: challenges and opportunities. Advances in Nutrition, 6(1):124-31.

[5] Haugen, H.K., Brurberg, K.G., Mann, J. and Aas, A.M. 2019. Carbohydrate quantity in the dietary management of type 2 diabetes: A systematic review and meta- analysis. Diabetes, Obesity and Metabolism, 21(1): 15-27.

[6] Ismail, S., Gherardi, M.J., Froese, A., Zanoun, M., Gigoux, V., Clerc, P., Gaits- Iacovoni, F., Steyaert, J., Nikolaev, V.O. and Fourmy, D. 2016. Internalized Receptor for Glucose dependent Insulin tropic Peptide stimulates adenylyl cyclase on early endosomes. Biochemical pharmacology, 120: 33-45.

[7] Isong D, Nkoyo B, and Joseph S. D. 2019. Proximate, mineral, antinutrient compositions and sensory properties of ayan-ekpang prepared with Cassava flour in akwa ibom state, Nigeria. Academic Journal of Global Who is Who in Academia, 2(2).

[8] Johnson-Down, L., L Abb, M.R., Lee, N.S. and Gray-Donald, K. 2003. Appropriate calcium fortification of the food supply presents a challenge. The Journal of nutrition, 133(7): 2232-2238.

[9] Kronzucker, H.J., Coskun, D., Schulze, L.M., Wong, J.R. and Britto, D.T. 2013. Sodium as.

[10] Kucukbay, F.Z., Yazlak, H., Sahin, N., Akdemir, F., Orhan,C., Juturu, V. and Sahin, K. 2008. Effects of dietary arginine silicate inositol complex on mineral status in rainbow trout (Oncorhynchus mykiss). Aquaculture Nutrition, 14(3): 257-262.

[11] Nirmala, C., Bisht, M. S., and Sheena, H. 2011. Nutritional properties of bamboo shoots: Potential and prospects for utilization as a health food. Comprehensive Review in Food Science and Food Safety, 10: 153-169.

[12] Otten, J.J., Hellwig, J.P. and Meyers, L.D. 2006. Dietary reference intakes: The essential guide to nutrient requirements. National Academies Press.

[13] Pandey, A.K. and Ojha, V. 2014. Precooking processing of bamboo shoots for removal of ant nutrients. Journal of Food Science and Technology, 51(1): 43-50.

[14] Pandey, A.K., Ojha V. and Choubey, S.K. 2012. Development and shelf-life evaluation of value-added edible products from bamboo shoots. American Journal of Food Technology, 7(6): 363-371

[15] Pharmaceutical industry. Trends in Food Science & Technology, 77: 91-99.Singhal, P., Bal, L.M., Satya, S., Sughakar, P. and Naik, S.N. 2013. Bamboo Shoots: A Novel Source of Nutrition and Medicine. Critical Reviews in Food Science and Nutrition, 53(5): 517-534

[16] Price, C.T., Koval, K.J. and Langford, J.R. 2013. Silicon: a review of its potential role in the prevention and treatment of postmenopausal osteoporosis. International Journal of Endocrinology, p. 6.

[17] Rawat, K., Sharma, V., Saini, N., Nirmala, C. and Bisht, M.S. 2016. Impact of Different Boiling and Soaking Treatments on the Release and Retention of Ant nutrients and Nutrients from the Edible Shoots of Three Bamboo Species. American Journal of Food Science and Nutrition Research, 3(3): 31- 41.

[18] Saini, N., Rawat, K., Bisht, M.S. and Nirmala, C. 2017. Qualitative and quantitative mineral element variances in shoots of two edible bamboo species after processing and storage evaluated by wavelength dispersion x -ray fluorescence spectrometry. International Journal of Innovative Research in Science, Engineering and Technology, 6(5): 8265- 8270.

[19] Saini, N., Rawat, K., Bisht, M.S. and Nirmala, C. 2017. Qualitative and quantitative mineral element variances in shoots of two edible bamboo species after processing and storage evaluated by wavelength dispersion x -ray

fluorescence spectrometry. International Journal of Innovative Research in Science, Engineering and Technology, 6(5): 8265- 8270.

[20] Shah, A., Niaz, A., Ullah, N., Rehman, A., Akhlaq, M., Zakir, M. and Suleman Khan, M. 2013. Comparative study of heavy metals in soil and selected medicinal plants. Journal of Chemistry, p. 5.

[21] Shah, D., Sachdev, H.S., Gera, T., De- Regil, L.M. and Pena- Rosas, J.P. 2016. Fortification of staple foods with zinc for improving zinc status and other health outcomes in the general population. Cochrane Database of Systematic Reviews, (6).

[22] Tolonen, M., 1990. Vitamins and minerals in health and nutrition. Elsevier.

[23] Uauy, R., Hertrampf, E. and Reddy, M., 2002. Iron fortification of foods: overcoming technical and practical barriers. The Journal of Nutrition, 132(4): 849S-852S.

[24] Waikhom, S.D., Louis, B., Sharma, C.K., Kumari, P., Somkuwar, B.G., Singh, M.W. and Talukdar, N.C. 2013. Grappling the high altitude for safe edible bamboo shoots with rich nutritional attributes and escaping cyanogenic toxicity. BioMed Research International.

[25] Weiner, I.D., Linas, S.L. and Wingo, C.S., 2018. Disorders of potassium metabolism. SPEC Comprehensive Clinical Nephrology, p.111.

[26] Welz, B., Lepri, F.G., Araujo, R.G., Ferreira, S.L., Huang, M.D., Okruss, M. and Becker Ross, H. 2009. Determination of phosphorus, sulfur and the halogens using high temperature molecular absorption spectrometry in flames and furnaces-a review. Analytica Chimica Acta, 647(2) 137-148.

[27] Whiting, S.J., Kohrt, W.M., Warren, M.P., Kraenzlin, M.I. and Bonjour, J.P., 2016. Food fortification for bone health in adulthood: a scoping review. European Journal of Clinical Nutrition, 70(10): 1099-1105.