

I INTRODUCTION

It is health that is real wealth, not pieces of gold and silver

-Mahatma Gandhi

The global population is growing at unprecedented rates, and demand for natural resources is also rising. As a result, humanity must create and adapt more sustainable methods of environmental preservation. Sustainable living entails a reduction in individual use of natural resources as well as the development of new strategies for living sustainably on the planet (Walker *et al.*, 2006). According to Food and Nutrition Research Institute (FNRI, 2012), the world's population is growing and by 2050, it is predicted to be over nine billion people. As the population grows, there is a good likelihood that the community's nutritional demands will grow by 70-100 percent, as will agricultural output.

Health is characterized as the ability to efficiently perform physically, mentally, socially, and spiritually in order to express the entire spectrum of one's individual potentialities within the milieu in which one lives. Sickness and health are dynamic processes, and each individual resides on a graded scale or continuous spectrum (continuum) ranging from wellness and optimal functioning in all aspects of one's life at one end to disease resulting in morbidity or mortality at the other.

Individuals who are dedicated about their health and fitness engage in regular exercise, eat a balanced diet, and get adequate sleep. Being healthy and fit helps people to keep them active but also boosting their self-esteem and attention. By maintaining a healthy and active lifestyle, one may set an example for others and gradually assist them in improving their health, nutrition, knowledge, and consumption of sustainably produced foods (Finkelstein *et al.*, 2003).

Eating nutritious food, exercising, getting enough sleep, and avoiding hazardous substances are just a few basic methods to keep individuals healthy and fit. These are linked to mental, bodily, and emotional well-being. A healthy lifestyle requires fitness and mental well-being. The advantages of leading an active and healthy lifestyle are apparent. Nutrition and exercise are vital for having a healthy lifestyle (Furrow *et al.*, 2004).

Food is essential for maintaining good health as well as for the prevention and treatment of illnesses (Cordain, 2016). The balanced food is the most significant single element in promoting health, and the wrong kind of food is the most significant single factor in promoting disease.

In other words, Kolb *et al.*, (2017) stated that nutrition which depends on food is crucial to the prevention and treatment of illness. The human body needs nutrients for the development and maintenance of healthy cells, tissues, glands, and organs that help with metabolic, hormonal, mental, physical, or chemical processes. According to reports, human cells require at least 45 vital nutrients. Oxygen, water, and the five main food groups which are carbohydrates, lipids, proteins, minerals, and vitamin are among them.

Vitamins are powerful organic substances that living things need in very little amounts to maintain proper health. They may be roughly classified into two groups: water soluble and fat soluble. Vitamins B complex and C are water soluble, while vitamins A, D, E, and K are fat soluble. Heat and light can degrade several vitamins. Vitamin precursors that are transformed into real vitamins when consumed by the body must be present in foods (De *et al.*, 2010).

The report by WHO (2022) stated that Non-communicable diseases (NCDs) such as heart disease, stroke, cancer, diabetes, and chronic lung disease account for 74% of all fatalities globally. Tobacco use, physical inactivity, hazardous alcohol use, and poor diets are all key risk factors for NCDs.

The word "micronutrient" refers to the important vitamins and minerals that must be obtained from the diet in order to maintain practically all normal cellular and molecular processes (West *et al.*, 2012). While the essential levels of micronutrients are extremely modest, untreated micronutrient deficiency (MND) can have far-reaching severe health consequences. MNDs are widespread, affecting an estimated 2 billion people globally. Although vitamin A, folate, iron, iodine, and zinc deficits are the most frequent, there are also additional MND problems (FNB, 2020). The World Health Organization (WHO, 2021) estimated that more than two billion people suffer from micronutrient deficiency globally.

Mineral deficiency is an important nutritional issue that affects both rich and poor countries. Iron (Fe), zinc (Zn), and selenium (Se) deficiency affect about 60%, 30%, and 15% of the world's seven billion people, according to researchers (White *et al.*, 2009). Mineral deficiency is on the rise, particularly in Asia and Africa (Muthayya *et al.*, 2013), where severe soil degradation has reduced the nutritional content of foods (Lal, 2009).

Awasthi *et al.*, (2022) opines that in Kerala, the prevalence of calcium and iron deficiency was fifty nine percent and forty nine percent respectively. 25 Hydroxy Vitamin D₃ deficiencies were seen in thirty nine percent and vitamin B12 in thirty three percent of subjects. Folate, Selenium and Zinc were deficient in twenty two percent, ten percent and six percent of the subjects respectively. Vitamin A deficiency was about one percent. Anemia was prevalent in seventeen percent subjects and was more common among females.

The body is made up of billions of living cells, and minerals are inorganic nutrients necessary for developing and maintaining those cells. They aid in preserving the amount of water required by the body's physiological functions. In addition to preventing the tissue fluid and blood from turning either too alkaline or excessively acidic, they aid in the movement of chemical compounds into and out of the cells. In addition to iron, calcium, magnesium, phosphorus, potassium, sulphur, and chlorine, other minerals like iodine, manganese, copper, zinc, cobalt, selenium, fluoride, silicon and other minerals are also required in trace amounts by the human body (De., 2018).

Willet *et al.*, (2013) opines that healthy diet includes plenty of vegetables, fruits, legumes, whole grains, nuts, seeds, and oils high in unsaturated fats and little to no red and processed meat, refined grains, sugar-sweetened beverages and oils high in saturated fats.

The living, edible parts of herbaceous plants are called vegetables. They are a crucial food that is very advantageous for maintaining health and preventing sickness. They have vital nutritional ingredients that the body may use to strengthen and restore it. Vegetables are important for preserving the body's alkaline reserve. They are

valued primarily for the significant amounts of minerals, vitamins, and carbohydrates they contain. Vegetables are available in different forms namely seeds, stalks, leaves, and edible roots (Dastagiri *et al.*, 2013).

Vegetables have been utilized as herbal remedies for hundreds of years in various regions of the world (Dias *et al.*, 2012). They provide a wide variety of nutritional and medicinal benefits. The non-nutritive phytochemicals may help keep the body operating normally. Understanding the effects of different dietary patterns on health requires an understanding of the antioxidant content and capacity of fruits and vegetables in relation to consumption data. According to a survey ginger, amaranth, sweet potato leaf, spinach, eggplant, cabbage, tomato, and onion were among the top ten vegetables in an antioxidant ranking.

Green leafy vegetables play a vital role in human nutrition because they supply necessary levels of several vitamins and minerals. They are high in vitamins such as beta-carotene, ascorbic acid, riboflavin, and folic acid, as well as minerals such as calcium, iron, and phosphorus. There are numerous underused greens in nature with promising nutritional content that can feed the ever-growing human population. Green leafy vegetables are essential for population nutrition, particularly in underdeveloped nations. Due to a diverse range of natural environments, temperatures, and seasons, India has a diverse range of leafy vegetable species. A significant amount of leaves from various sources are ingested, including permanent trees, aquatic plants, and annuals (Santos *et al.*, 2012).

Some of the commonly consumed leafy vegetables are spinach (*Spinacia oleracea*), amaranth (*Amaranthus gangeticus*), fenugreek (*Trigonella foenum graecum*), drumstick (*Moringa oleifera*), cabbage (*Brassica oleracea* var. capitata), bathua (*Chenopodium album*), etc. (Edelman *et al.*, 2016). These greens are inexpensive, high yielding, a part of the local diet and easily available. Some of the greens are also used as leafy spices because of their flavour such as curry leaf (*Murraya koenigii*), coriander leaves (*Coriandrum sativum*), mint (*Mentha spicata*), bay leaf (*Laurus nobilis*), basil (*Ocinum basilicum*), etc.

Green leafy vegetables have been used for generations as a gift for a safe and healthier existence. They supply sufficient amounts of numerous vitamins and minerals to people (Randhawa, 2015). They are rich sources of oil, carbohydrates, carotene, ascorbic acid, retinol, riboflavin, folic acid and minerals like calcium, iron, zinc, magnesium, manganese and selenium depending on the vegetable consumed (Shukla *et al.*, 2016).

Due to their relatively low calorie content, leafy greens are excellent for weight maintenance. Because they are low in fat, high in dietary fibre, high in folic acid, vitamin C, potassium, and magnesium, as well as a variety of phytochemicals including lutein, beta-cryptoxanthin, zeaxanthin, and beta-carotene, they are beneficial in lowering the risk of cancer and heart disease. The majority of researchers have discovered that consuming green leafy vegetables reduces the chance of acquiring cardiovascular disease (Wang *et al.*, 2016).

As the world's population continues to rise, there is a greater demand for sustainable food sources, such as high-nutrient functional crops (Aletor *et al.*, 2002). Ongoing attempts are being made to develop new food production systems to suit the demands of the world's rising population. Microgreens have recently gained popularity as a high-nutrient crop with a high concentration of nutrition components, such as vitamins, minerals, and antioxidants, as compared to adult greens, which can help address nutritional gaps. Microgreens are also useful functional crops because of their high phytonutrient content (Britton *et al.*, 2006; Asaolu *et al.*, 2012).

Micro greens, also known as 'Vegetable Confetti,' are a type of distinguishing crop. Its described as soft juvenile greens grown from the seeds of herbs, vegetables or cereals, as well as wild forms. As there has been a surge in the popularity of healthy eating, gourmet cuisine, and indoor gardening in developed nations, micro greens have gained notoriety. Even in the refrigerator, this new type of food has a short shelf life and is used in minor amounts as toppings, garnishes or spices (Riggio *et al.*, 2019).

The young edible vegetables and herbs called microgreens are an emerging food that are picked after the first leaf appear and the cotyledonary leaves have fully matured after 7 to 21 days after germination (Allegretta *et al.*, 2019).

Microgreens are 2.5–7.6 cm (1–13 in.) tall, picked 7–14 days after germination, and sold with the stem and attached cotyledons (seed leaves), depending on the species. Microgreens, despite their small size, may produce a wide range of powerful tastes, vibrant colours, and soft textures. As a result, microgreens may be utilised as a new element in salads, soups, and sandwiches to enhance colour, texture, and/or flavour, as well as an edible garnish to liven up a range of main courses (Lee *et al.*, 2004; 2009; Treadwell *et al.*, 2010).

The primary producers are nations in North America and Europe. Microgreens may be made from any grain or seed. Monocotyledons and dicotyledons are two types of grains used to make microgreens. They need a lot of light, especially natural sunshine, as well as low humidity and sufficient air movement. Large seeded species like pea and chickpea have 1 seed per cm²; tiny seeded species like cabbage, broccoli, radish, and amaranth have up to 4 seeds per cm² (Gioia and Santamaria, 2015).

Micro greens are harvested after a few days or weeks after germination, during the formation of cotyledons and the emergence of the first true leaves (Paradiso *et al.*, 2018). Microgreens are distinguished by the diversity of colours, textures and tastes. These are always fresh and tenderly soft vegetables that come from the seeds of multitudinous varieties of vegetables, aromatic herbs, wild edible plants, and herbaceous plants.

Since the availability and consumption of microgreens are significantly influenced by the emergence of culinary trends, the species' selection relies on manufacturer discussions with chefs and on consumer acculturation to their unique sensory qualities. Microgreens can be distributed as freshly cut foods as well as while growing on medium for end users to harvest.

The most often exploited species are those belonging to the groups Amaranthaceae, Apiaceae, Amarillydaceae, Asteraceae, Brassicaceae, Chenopodiaceae, Cucurbitaceae and Lamiaceae,. Bioactive substance is noticeable in several types of very harsh tastes (like Brassicaceae), and its varying adequacy necessitates identifying proof of genotypes that may take needs for both flavour and wellness into account (Lester *et al.*, 2012).

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Microgreens are loaded in nutrients. Many varieties are rich in potassium, iron, zinc, magnesium, and copper despite the concentration variations that may occur (Xiao *et al.*, 2016). Microgreens are an excellent source of important plant components like antioxidants. Additionally, they contain more vitamins, minerals, and antioxidants per serving than the mature greens (Xiao *et al.*, 2012).

Microgreens are regarded as functional foods because, in addition to their nutritional advantages, they have higher concentrations of phenolics, antioxidants, minerals, and vitamins than are present in fully formed greens or seeds (Mir *et al.*, 2017). These are widely acknowledged as effective carriers of biologically active ingredients.

Eating microgreen vegetables is linked to a lower risk of numerous diseases because they contain large amounts of vitamins, minerals, and beneficial plant chemicals. Microgreens are likewise endowed with such essential elements that keep us healthy (Carter *et al.*, 2010).

The antioxidant polyphenol, which decreases the risk of heart disease, is abundant in microgreens. According to many animal studies, microgreens may reduce levels of LDL, the bad cholesterol and triglycerides (Tangney and Rasmussen, 2013, Huang *et al.*, 2016).Foods high in antioxidants, such as polyphenols, can reduce the risk of memory-related diseases like Alzheimer's (Guest and Grant, 2016).

According to Bull, (2008), Micro greens, in contrast to their fully developed veggie counterparts, have antioxidants and a variety of polyphenols, according to studies. Riggio *et al.*, (2019) stated that Microgreens are sometimes confused with growing seeds (sprouts), which have been linked to foodborne illness. However, microgreens have certain characteristics with sprouts, fresh herbs (such as thyme, basil and cilantro) and miniature greens (such as spring mix and baby spinach). Several researches have studied the nutritional and physiological features of microgreens, but only a few papers have specifically evaluated the food safety dangers of microgreens since 2009, although international studies have been conducted to investigate the safety of leafy greens and sprouts.

Antioxidants can aid in lowering the risk of developing type 2 diabetes. In laboratory tests, it is anticipated that fenugreek microgreens may boost cellular sugar absorption by 25–44%. (Wadhawan *et al.*, 2018). Microgreens are high in antioxidants, especially those with polyphenols, may reduce the risk of developing several cancers (Zhou *et al.*, 2016).

Microgreens are not only simple to cultivate but also good source of many different nutrients and are beneficial to the environment (Weber, 2017). For instance, cultivating microgreens only needs 10 to 14 days. Additionally, according to a research, microgreen broccoli needs 158–236 times less water and 93–95% less time than mature broccoli to produce the same amount of nutrients. Microgreens also don't require pesticides, fertilizers, or energy-intensive transportation from farm to table. Growing conditions are crucial because they have a direct impact on plant development and phytonutrient concentrations. The seed sowing rate, nutrients, and light exposure that impact the growth of microgreens.

Majority of the growers choose peat-based mixtures or synthetic mats, while early growth on filter paper has been employed in experimental settings to explore germination media additives such as leftover brewer's yeast (Verlinden, 2020, Lobiuc *et al.*, 2017). Anon., 2016 and Verlinden, 2020 tested composts combined with sand and vermiculite, as well as sand, coconut coir dust, peat, sugarcane filter cake and vermicompost in various proportions. All of the proportions were successful in growing microgreens (Muchjijab *et al.*, 2015).

Several ways for delivering ideal greenhouse conditions to boost microgreen production were used and developed. Light emitting diodes (LEDs) are the novel light source technology that is being employed in greenhouses and plant development chambers with limited space (Judith., 2004; Fasugi.,2005). High efficiency and cheap cost,as well as the flexibility to adapt light characteristics to varied light intensities and wavelengths (Gopalan *et al.*, 2000, Galloway, 2003), make it more economically feasible.

Microgreens require less photon flux than long-cycle crops, making them well-suited to chamber settings. Many recent research have established the effect of LEDs (blue or/and red) lighting on plant vegetative parameters (Gopalan *et al.*, 2004, Fasugi., 2005, Gibson *et al.*, 2006) and the effect of light quality on cultivated plant growth (Hamazalli *et al.*, 2001, Guil *et al.*,2016, Silva *et al.*, 2017, Guerrero *et al.*, 2019).

Microgreens may be cultivated in a variety of environments. Some farmers prefer perlite, while others prefer a blend (Johnson 2012 and Verlinden, 2020, Gioia *et al.*, 2016). According to Bulgari *et al.*, (2017), microgreens were cultivated hydroponically in a floating hydroponic system. Seeds were planted in vermiculite-filled polystyrene cell trays. Seed germination took place at 24°C in the dark in a climate room. Rocket seeds sprouted in two days after seeding, but basil and Swiss chard took three days to germinate. Following by the germination, the trays were placed in a polyethylene (PE) tank (30/60/6.5cm³) containing 5 L of half-strength Hoagland nutritional solution for each tray. Prepared using distilled water at a pH of 5.56 with an initial electric conductivity of 1.12ms cm⁻¹.

Microgreens nutritional quality has been demonstrated to be influenced by pre- and post-harvest manipulations. Preharvest treatments generally attempt to boost production, eradicate pathogens, and reduce safety risks. To improve the nutritional content of microgreens, several preharvest intervention procedures have been used. The application of light to microgreens can effectively accelerate seed germination and influence microgreen production (Dowdle *et al.*, 2007; Wang *et al.*, 2017).

Microgreens are considered to be extremely perishable items since they are sensitive and have a limited shelf life (1-2 days) at room temperature (Kou *et al.*, 2012). One of the most important elements determining the postharvest physiology and storage behavior of produce is storage temperature. By slowing down respiration rates, senescence, and the development of rotting microgreens, low-temperature storage can generally prevent quality loss and lengthen shelf life. Therefore, choosing the ideal storage temperature is essential.

Despite the fact that micro greens are designed to be highly decomposable products, their fast decomposition, high cost, and short storage life which ranges from 3 to 5 days at ambient temperature have sadly hindered their commercialization. As the need for microgreens grows, so does their presence in farmer's markets and specialized food shops. As a result, the enhancement of their packaging and post-collection storage conditions is becoming increasingly important for increased timeframes of realistic usage (Mir *et al.*, 2017).

Microgreens are recognized as "Super Foods" due to their numerous health and nutritional advantages (Ravikishore *et al.*, 2022). In addition, growing microgreens is very simple and practical, needing little space and little financial commitment. Therefore, it should be encouraged in urban regions where there is a shortage of space and in peri-urban areas where there is a shortage of resources (money). It has the ability to address the population's nutritional and food security.

People are becoming more aware of the value of microgreens these days. As a result, residents in rural, urban, and sub-urban areas may take advantage of the nutritious potential of microgreens at home and at the market. Although the procedure of cultivating microgreens is simple, it is necessary to consider the commercial requirements of microgreens in order to cultivate them successfully (Kumar *et al.*, 2015).

Hence the present study entitled “**Cultivation and Nutritional Profiling of Selected Varieties of Microgreens and their Acceptability in Incorporated Recipes**” has been undertaken to achieve the following objectives:

- To study the type of medium and other growing conditions required for the cultivation of the selected microgreens.
- To study the growth of selected varieties of microgreens and to analyze the nutrient content, toxic elements and their shelf life.
- To develop recipes with grown varieties of microgreens and to analyze their sensory characteristics.
- To analyze the Knowledge, Attitude and Practice (KAP) of the selected subjects with respect to microgreens.
- To impart awareness to selected subjects regarding the cultivation techniques and benefits of microgreens.

Hypothesis 1

- H_0 = There is no significant association between the micronutrient content and microgreens in comparison to the mature counterparts (regular greens)
- H_1 = There is a positive association between the micronutrient content and microgreens in comparison to the mature counterparts (regular greens)

Hypothesis 2

- H_0 = There is no association between the awareness created and knowledge level of the selected subjects post awareness
- H_1 = There is a positive association between the awareness created and knowledge level of the selected subjects post awareness.