DEVELOPMENT OF RTE MILLET MIXES WITH FRUIT AND VEGETABLE PEEL

By

P.SANTHOSHINI

(14PFN011)

A THESIS SUBMITTED TO THE

AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN, COIMBATORE-641 043.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN FOOD SCIENCE AND NUTRITION

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Certified as a Bonafide Research Work

K. Balasaraswathi 29/4/16
Signature of the Supervisor

M. Amirthaveni 29/4/16
Signature of the Head of the Department

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I. INTRODUCTION

"To eat is a necessity, but to eat intelligently is an art"

-La Rochefoucauld

Fruits and vegetables are important components of a healthy diet. Reduced fruit and vegetable consumption is linked to poor health and increased risk of Non Communicable Diseases (NCDs). An estimated 5.2 million deaths worldwide were attributable to inadequate fruit and vegetable consumption in 2013. Fruits and vegetables are rich sources of vitamins and minerals, dietary fibre and a host of beneficial non-nutrient substances including plant sterols, flavonoids and other antioxidants. Consuming a variety of fruits and vegetables helps to ensure an adequate intake of many of these essential nutrients. WHO (2013) suggests consumption of more than 400 grams of fruits and vegetables per day improves overall health and reduces the risk of certain NCDs (www.who.int).

Diets high in fruits and vegetables are widely recommended for their health-promoting properties. Fruits and vegetables have historically held a place in dietary guidance because of their concentrations of vitamins, especially vitamins C and A; minerals, especially electrolytes; and more recently phytochemicals, especially antioxidants. Additionally, fruits and vegetables are recommended as a source of dietary fiber (Valvarde *et al*., 2014).

Regular consumption of lycopene present in fruits and vegetables has been linked to decreased incidence of prostate cancer, lung cancer, digestive tract cancer and cardiovascular disease. It has been shown to induce cell-to-cell communication, modulate hormones and immune systems and affect other metabolic pathways (Kuti, 2005).

Fruits and vegetables are considered as an important part of a good diet. Vegetables and fruit offer more nutritional benefits when harvested at their peak maturity. It is inevitable for fruits and vegetables to start deteriorating soon after harvest when there is a discontinued connection to their source of nutrients. Fruits and vegetables have over 90% water and harvest results in moisture loss thus leading to the deterioration in quality and spoilage from other microbial activities (Rickman *et al*., 2007).

Consuming fruits and vegetables of all kinds has long been associated with a reduced risk of many adverse health conditions. Many studies have suggested that increasing consumption of plant foods like cucumber decreases the risk of obesity, diabetes, heart disease and overall mortality while promoting a healthy complexion, increased energy and overall lower weight (www.medicalnewstoday.com). The shelf life of fruits and vegetables is very limited generally just a few days. Storing vegetables by freezing and canning methods stop plant respiration, thereby reducing both moisture loss and microorganism growth (Rickman *et al*., 2007).

Global demands for banana and plant portion are a cumulative of its use as a rich source of essential nutritional, nutraceutical and bioactive compounds, source of several industrially utilized enzymes, food preservatives and as vital components in several animal feed. Apart from food uses, banana plant portion are used for other purpose too (Padam *et al*., 2012). Banana is rich in potassium and fiber; banana leaf is rich in potassium. Taking hot foods on the leaf regularly may prevent stroke. Value addition to banana through processing can be brought about by converting them into various products like chips, jam, jelly, puree, powder, syrups, health drink and baby foods etc. Being a good source of iron, banana can stimulate the production of hemoglobin in the blood and help in cases of anemia. They also help to reduce the risk of blood pressure and stroke (Janagi and Lakshmi, 2008).

Grapes are known for having a high nutritional value. Grapes are rich in vitamin C and vitamin K. They contain low levels of cholesterol, fat and sodium. Grapes are known for their proteins, carbohydrates, dietary fiber, vitamins and minerals. They contain high amounts of caffeic acid, which is a strong cancer - fighting substance. Grapes contain flavonoids, which are powerful antioxidants (www.arizona.edu).

Potatoes are one of the most common and important food sources on the planet and they contain a wealth of health benefits that make them all the more essential as a staple dietary item for much of the world’s population. These health benefits include their ability to improve digestion, reduce cholesterol levels, boost heart health, protect from polyps, prevent cancer, manage diabetes, strengthen the immune system, reduce signs of aging, protect the skin, increase circulation, reduce blood pressure, maintain fluid balance, reduce insomnia and boost eye health (www.organicfacts.net).

Fruits and vegetable wastes and their by-products are formed in great amounts during industrial processing and hence represent a serious problem, as they exert harmful impact on environment. Peels of various fruits and vegetables are generally considered as waste product and are normally thrown away. Number of components having activities like antioxidant, antimicrobial, antiinflammatory, antiproliferative etc. have been isolated from different peels (Parashar *et al,* 2014).

Fruit and vegetable wastes and by-products, exert an influence on environment and need to be managed and/or utilized. They are very rich in bioactive components, which are considered to have a beneficial effect on health. For the last decade, efforts have been made to improve methods and ways of reusing fruits and vegetables wastes (Chodak *et al*., 2007). In olden days people were healthy enough to do their household activities and free from diseases/illness due to the consumption of more varieties of minor millets, which is lacking in the present day scenario. Hence consuming these minor millets is of great importance to lead a disease free life.

Minor millets are a group of grassy plants with short slender culm and small grains possessing remarkable ability to survive under adverse conditions like limited rainfall, poor soil fertility and land terrain. Minor millets categorized as coarse cereals are staple food for the tribal people where cultivation of major cereals like rice, wheat and maize is either not popular or fail to produce substantial yield (Chandel *et al*., 2014).

India is considered as core for production of minor crops, world total production of millet grains was 762,712 metric tons and India as top producer with an annual production of 334,500 tones contributing 43.85% (FAO, 2013). In the inhabitants of Bastar district of Chhattisgarh, the largest congregations of tribal population (67.4%), mainly grow millets and form major component of their daily food consumption. In addition to be nutritionally rich, the advantage of growing minor millets is that it is a rain fed crop which forms part of a multi-cropping system, that it is mostly grown along with legumes and oilseeds (Chopra *et al*., 2004, Pradhan *et al*., 2010). On the darker side, these are underutilized and neglected crops owing to their lower preference driven by affluence, longer time and efforts involved in processing of the millets and lower cooking quality. Their high nutritional value can make millets doubly valuable as food for farming families and a potential source of income.

The millets have high fiber content, their protein quality and mineral composition contribute significantly to nutritional security, in the millet growing areas (Desai *et al*., 2010). Millets are highly nutritious, non-glutinous and non-acid forming foods, soothing and easy to digest. They are least allergenic and most digestible grains available (Stanly *et al*., 2013). Millets are also rich source of phytochemicals and micronutrients (Mal, 2010; Singh *et al*., 2012). Millets also contain B vitamins especially niacin, B6 and folic acid, calcium, iron, potassium, magnesium and zinc (Vachanth *et al*., 2010). It also contains higher proportion of unavailable carbohydrates and release of sugar from millet is low (Karuppasamy *et al*., 2011).

Traditionally breakfast cereals were prepared using corn. Due to the recent advancement in technology breakfast cereals are made using different cereal sources like wheat, rice, maize, oats, rye, barley, sorghum and other millets which are known to be excellent sources of carbohydrates, dietary fiber, protein, vitamin and minerals (Bharya *et al*., 2012).

The presence of all the required nutrients in millets makes them suitable for large scale utilization in the manufacture of food products, such as baby foods, snack foods and ready to eat foods. Increasing more millet products have entered into the daily lives of people including millet porridge, millet wine and millet nutrition powder from both grain and flour form (Subramanian and Viswanathan, 2007; Liu *et al*., 2012). Inclusion of these millets in the daily plate with fruits and vegetables can add bulk and nutritive value to our diet. But fruits and vegetables as they perish quickly because of high moisture content and/or due to the seasonal availability they can be used in the preserved forms. The fruits and vegetables can be preserved in many ways. The peels has high nutritive value and a potential antioxidant can also be preserved and used effectively. One such method of preservation is drying, an age old technique.

Drying is a process of dehumidification in which moisture is removed from a solid using thermal energy. In the design of a drying system, product quality, economic viability and environmental concerns should be taken into consideration (Hawlader *et al.*, 2013). Drying is a significant step on food and food additive processing. The position of drying becomes more and more strategic due to the changes in life style of modern people who prefer to find high quality dry products close to the fresh or natural condition. An example is milk powder that can be stored for a period longer than a year instead of some weeks and for which the transportation volume is 8-10 times reduced (Birchal *et al.*, 2005; Djaeni, 2008).

Applications range from on-farm drying of grain, fruits and vegetables to large scale commercial drying of fruits, vegetables, snack food products, milk products, coffee and other products. Although certain basic factors are involved in all drying processes, the equipment and techniques vary greatly depending upon the product and other factors (Wihelm *et al.*, 2009). There are various types of dryers like drum dryer, vaccum dryer, freeze dryer, tray dryer, osmotic dryer, spray dryer, bed dryer, microwave and sun drying used for dehydration of foods. For the present study, the effective methods used for dehydration were tray drying, microwave drying and sun drying with controlled heat and air circulation.

Tray dryers are usually small, insulated units with a heater, circulating fan and shelves to hold the product to be dried. Different designs are used, but the general procedure is to force heated air over multiple trays. Small-scale cabinet dryers are typically single pass units. However, greater energy efficiencies can be obtained if some of the heated air is recirculated (Wihelm *et al.*, 2009). Microwave ovens are popular for reheating previously cooked foods, cooking a variety of foods and dehydrate some foods. They are also useful for rapid heating of otherwise slowly prepared cooking items, such as hot butter, fats and chocolate. Some modern microwave ovens are part of over-the-range units with built-in extractor hoods (Labuza *et al*., 2011).

Sun drying is the evaporation of water from products by sun or solar heat, assisted by movement of surrounding air. It demands a rainless season of bright sunshine and temperatures above 98˚F coinciding with the period of product maturity. Products must be protected from insects and must be sheltered during the night (www.extension.usu.edu).

Busani *et al*., (2011) expressed that there was better retention of nutrients like protein and crude fat and nutritional characteristics as compared to the oven, shadow drying and sun drying methods. Also, it takes a shorter period to dry using microwave and cabinet tray dryer which resulted in accumulation of nutrients.

Convenience food is perceived expensive by people besides being out-of-way meals in Indian culture. In today's scenario, convenience food industry is getting adapted to Indian type of requirements and is growing leaps and bounds in India. The working women also are not shy to explore these convenience foods into their kitchen (Takhellamban *et al.,* 2015). Convenience food is commercially prepared for ease of consumption. Products designated as convenience foods are often sold as hot, ready-to-eat dishes; at room-temperature, shelf-stable products; or as refrigerated or frozen food products that require minimal preparation. Convenience foods have also been described as foods that have been created to "make them more appealing to the consumers (Anderson *et al*., 2009). Convenience foods offer many benefits, including less time spent planning meals and grocery shopping, less preparation time, fewer leftovers (with single-portion foods) and easier cleanup. (Minton, 2012).

Advancement in science and technology has paved the way in upsurge of food industry. Ready To Eat foods are those foods which are partially cooked and can be utilized in a very convenient form within a short duration and it can be considered as one of the alternative home cooked meal. A fastpaced urban lifestyle, increasing dominance of nuclear family structure, rising disposable income, convenience of use have made RTE foods popular. Provision of such RTE foods based on nutritious grains such as millets would be more meaningful in the modern times in the management of life style disorders (Takhellamban *et al.,* 2015)

Considering the above mentioned nutritional and health benefits of millets, fruits and vegetables and importance of RTE mixes, the present investigation entitled **"Development of RTE millet mixes with fruit and vegetable peel"** was carried out with the following objectives:

Primary objectives

- Nutrient analysis of the selected fresh and dehydrated fruits and vegetable peel
- Development of RTE millet mixes incorporated with dehydrated fruit and vegetable peels

Secondary objectives

- Dehydration of the selected fruit and vegetable peels using different dehydration methods
- Analysis of the nutritive value of the fresh and dehydrated fruit and vegetable peels
- Analysis of anti-nutritional substances in selected dehydrated fruit and vegetable peels
- Selection of millets and recipes
- Development and standardization of millet based RTE mixes
- Incorporation of dehydrated peels into the standardized RTE mix
- Sensory evaluation of the developed millet based RTE mixes

II. REVIEW OF LITERATURE

The review of literature pertaining to the study entitled "**Development of RTE millet mixes with fruit and vegetable peels**" is reviewed under the following headings:

i. Health benefits of fruits and vegetables
ii. Nutritional importance of fruit and vegetable peel
iii. Drying as a method of preservation
iv. Nutritional Importance of millets
v. Convenience foods used in our daily life

i. Health benefits of fruits and vegetables

Higher fruit and vegetable consumption is one of the characteristic of the 'prudent diet' along with higher intakes of fish, whole grains and poultry (Quatromoni and Copenhafer, 2002; Millen and Quatromoni, 2005). It is also associated with low risk of ischemic heart disease and all-cause mortality (Kobylecki *et al*., 2015). Bazzano *et al*., 2002 also showed an inverse association of fruit and vegetable intake with the risk of cardiovascular disease and all-cause mortality in the general US population. Longitudinal cohort study, higher intake of F/V during young adulthood was associated with lower odds of prevalent coronary artery calcium after 20 years of follow-up. (Michael and Miedema, 2015). Liu *et al*., 2000 also supported same and showed that they may be protective against CVD and support current dietary guidelines to increase fruit and vegetable intake.

Dagenais *et al*., (2000) examined the effects of supplemental forms alone of the antioxidants, vitamin C, carotenoids and vitamin E and proved no effect on cardiovascular events, indicating that it may be these vitamins in combination with the other components of fruit and vegetables that confer the beneficial effects on Cardiovascular Disease (CVD).

Low intake of fruit and vegetables has been shown to be independently associated with a increased risk of CVD (Cupples *et al*., 1995; Ness and Powles 1997; Ascherio *et al*., 1999; Manson *et al*., 2000; Hu *et al*., 2001; WHO, 2003)

Thomas in 2004 reported that the nutritional management of both Type I and Type II diabetes involves a diet where the consumption of five or more portions of fruit and vegetables is fundamental. A diet containing 45 to 60 per cent carbohydrate, mainly derived from complex, fibre rich foods with a low glycaemic index (*ie.* foods that contain carbohydrates which are released more slowly into the blood stream, which means that blood sugar levels stay steady) such as starchy cereal foods, fruits and vegetables is recommended.

Bingham *et al*., (2001) estimated in an EPIC study that, adding two more daily portions of fruit and vegetables could reduce the risk of premature death by as much as half. These findings hold regardless of age, blood pressure or smoking. Dowell *et al*., 2007 opined that fruits and vegetables are naturally low in sodium and a rich source of potassium in the diet. In the case of stroke risk, sodium has a negative association while potassium has a positive effect on CVD event. A meta-analysis of existing evidence concluded that a higher intake of folate (0.8 mg folic acid) would reduce the risk of ischaemic heart disease by 16 per cent and stroke by 24 per cent (Law *et al*., 2002).

Liu in 2003 proposed that the additive and synergistic effects of phytochemicals in fruits and vegetables are responsible for their potent antioxidant and anticancer activities and that the benefit of a diet rich in fruits and vegetables is attributed to the complex mixture of phytochemicals present in whole foods. Phytochemicals can have complementary and overlapping mechanisms of action, including modulation of detoxification enzymes, stimulation of the immune system, reduction of platelet aggregation, modulation of cholesterol synthesis and hormone metabolism, reduction of blood pressure and antioxidant, antibacterial and antiviral effects. (Lampe, 1999)

Epidemiological studies have established a positive correlation between the intake of fruits and vegetables and prevention of diseases like atheroscelerosis, cancer, diabetes, arthritis and also ageing. Fruits and vegetables have thus had conferred on them the status of 'functional foods', capable of promoting good health and preventing or alleviating diseases. Phenolic flavonoids, lycopene, carotenoids and glucosinolates are among the most thoroughly studied antioxidants (Kaur *et al*., 2008). Major phenolics in apple and their contribution to the total antioxidant capacity were examined by Lee *et al.,* (2003) and the results indicated that flavonaids such as quercetin, epicatechin, procyanidin B_2 rather than vitamin C contribute significantly to the total antioxidant activity of apples.

Some fruits like bananas offer great medical benefits. This is partly because bananas aid in the body's retention of calcium, nitrogen and phosphorus, all of which work to build healthy and regenerated tissues (Kumar *et al*., 2012). Bananas can be used to fight intestinal disorders like ulcers. Bananas are one of the few fruits that ulcer patients can safely consume. Bananas neutralize the acidity of gastric juices, thereby relieve painful ulcer systems and other intestinal disorders and also promote healing (Kumar *et al*., 2012).

Potassium is found in a variety of fruits and vegetables and even meats, however a single banana provide 23 per cent of the potassium. Potassium benefits the muscles as it helps maintain proper working and prevents muscle spasms, decrease blood pressure and reduce the risk of stroke (Kumar *et al*., 2012). Bananas could be helping to reduce the risk of kidney cancer, the greatest protection against renal cancer. Women eating 5 bananas a week nearly halved their risk of renal cancer (Rashidkhani, 2005). Regular consumption of banana and orange in the first two years of life consistently reduced a child's risk of childhood leukemia before the age of 15 years (Kwan, 2004). The authors speculate that the vitamin C and potassium may be playing a protective role.

Flavonoids are the main group of active anticancer constituents in grape products and are concentrated mainly in grape skins and seeds. Researchers have shown that grape skin extract possesses chemotherapeutic efficacy against breast cancer with metastases in model system. Extracts of raisins from two grape varieties (*V. vinifera* "Currant" and "Sultana" var.) were investigated for their effect on human colon cancer cells and found that both extracts exhibited cancer preventive efficacy on colon cancer cells by having antioxidant and anti-inflammatory effects (Rodríguez *et al*., 2014).

Papaya fruit is a rich source of nutrients such as provitamin A carotenoids, vitamin C, B vitamins, lycopene, dietary minerals and dietary fibre. Danielone is a phytoalexin found in the papaya fruit. Papaya seed extract may have toxicity-induced kidney failure. Evidently a kidney-transplant patient in London was cured of a post-operative infection by placing strips of papaya on the wound for 48 hours. Women have long used green papaya as an herbal medicine for contraception and abortion (Adebiyi *et al.,* 2010).

Citrus fruits also contain an impressive list of other essential nutrients, including both glycaemic and non-glycaemic carbohydrates sugars and fibre, potassium, folate, calcium, thiamine, niacin, vitamin B6, phosphorus, magnesium, copper, riboflavin, pantothenic acid and a variety of phytochemicals (Whitney and Rolfes, 2010). *Citrullus lanatus* (water melon) contains about 6% sugar and 92% water by weight. The composition of dried egusi seed without shell per 100 g include: water 5.1 g, energy 2340 KJ (557 kcal), protein 28.3 g, fat

47.4 g, carbohydrate 15.3 g, calcium 54 mg, phosphorous 755 mg, iron 7.3 mg, thiamine 0.19 mg, riboflavin 0.15 mg, niacin 3.55 mg and folate 58 μg. The seed being an excellent source of energy and contains no hydrocyanic acid, making it suitable as livestock feed. The seed oil contains glycosides of linoleic, oleic, palmitic and stearic acids. The fruit flesh contains bitter cucurbitacins (Schippers, 2012).

Monro in 2009 said that potatoes contain very little soluble sugar, nearly all of the carbohydrate in potatoes is in the form of hydrated starch. Starch contributes about 17 kJ/g energy compared with 37 KJ/g for fat, and starch is hydrated because in cooked potato KJ per gram are even lower. Potato, has a role to play in managing the obesity that is contributing to the current burden of disorders such as diabetes and heart disease, although the starch in potatoes is readily digested, as indicated by the high glycaemic index values, the high water content of potatoes means that on a weight for weight basis they have a relatively low impact on blood glucose - about one-third that of bread.

Potatoes should not be relied on as a source of dietary fibre as they contain little of it, and it is easily fermented. This does, however, have some benefits because it means that people with extremely high energy intakes, such as athletes, do not become overburdened with the non-digestible food residues can contribute extra energy as short-chain fatty acids, water soluble vitamins, vitamin C and B group vitamins, especially thiamin and folic acid (Miller *et al.,* 2008).

As a member of the *Cucurbitaceae* family of plants, cucumbers are a rich source of triterpene phytonutrients called cucurbitacins. They have anti-cancer properties. For cancer cell development and survival can be blocked by activity of *cucurbitacins.* Cucumbers contain lariciresinol, pinoresinol, and secoisolariciresinol—three lignans that have a strong history of research in connection with reduced risk of cardiovascular disease as well as several cancer types, including breast, uterine, ovarian and prostate cancers. Fresh extracts from cucumbers have both antioxidant and anti-inflammatory properties, help scavenge free radicals, help improve antioxidant status, inhibit the activity of pro-inflammatory enzymes like cyclo-oxygenase 2 (COX-2) and prevent overproduction of nitric oxide, supporting health of the conventional antioxidant nutrients—including vitamin C, beta-carotene, and manganese (www.whfoods.com).

ii. Nutritional importance of fruit and vegetable peel

Peels are the major by-products obtained during the processing of various fruits. These are good sources of many bioactive components which possess various beneficial effects on human health (Maniyan *et al*., 2015). The peels of a variety of plants and fruits are currently the focus of a great deal attention as a natural source of antioxidants, which are rich in compounds with free radical scavenging activity. They have health related properties that include anticancer, antiviral and antioxidants activities (Lee *et al.,* 2010).

Plant food residues including trimmings and peels might contain a range of enzymes capable of having a wide range of applications. Proteolytic enzyme bromelain may be extracted from the mature pineapple and papain from latex of papaya fruit. Banana waste can be used for the biotechnological production of α-amylase (Krishna and Chandrasekaran, 1996), hemicellulase (Medeiros *et al.,* 2000) and cellulase (Krishna, 1999).

Fruit and vegetable wastes/by-products such as apple, pear, orange, peach, black currant, cherry, artichoke, asparagus, onion and carrot pomace, mango peels and cauliflower trimmings are used as sources of dietary fibre supplements (gelling and thickening agents) in refined food (Schwartz *et al.,* 1988).

Amongst various wastes used for ethanol production, potato peels (Arapoglou *et al.,* 2010), apple pomace, waste apples (Tahir and Sarwar, 2012), banana peel, banana waste (Tewari, Marwaha and Rupal, 1986; Oberoi *et al.,* 2011a), beet waste, beet pomace (Dhabekar and Chandak, 2010), kinnow mandarin *(Citrus reticulata)* waste (Oberoi *et al.,* 2011) and peels (Sandhu *et al.,* 2012) and peach wastes have the capacity to increase ethanol production.

The citrus peels are a potential source of Essential Oil (EO) and yield 0.5 to 3.0 kg oil/tonnes of fruit (Sattar and Mahmud, 1986). Citrus EO is widely used in alcoholic beverages, confectioneries, soft drinks, perfumes, soaps, cosmetics and household products owing to its aromatic flavor. It also serves as a masking agent in pharmaceutical products (Njoroge *et al.,* 2005). It improves the shelf-life and the safety of fresh fruits (Lanciotti *et al.,* 2004), skim milk and low-fat milk (Dabbah, Edwards and Moats, 1970) and exhibits broad spectrum antibacterial activity (Javed *et al.,* 2011). Fat'hi and Zolfi, (2012) said that certain compounds in passion fruit peel has bronchodilator effect and can help relieve bronchospasm in asthma patients. Guo *et al*., 2003 revealed that peel and seed fractions of some fruits, such as pomegranate peel, grape seed, hawthorn peel, longan and lychee seeds possessed relatively high antioxidant activity and might be rich sources of natural antioxidants.

Babbar *et al.* (2011) reported that kinnow peel, litchi pericarp, litchi seeds and grape seeds can serve as potential sources of antioxidants for use in food and pharmaceutical industries. The beet root pomace is a rich source of flavonoids (Čanadanović *et al.,* 2011). The phenolic portion of the beet root peel depicts l-tryptophane, p-coumaric and ferulic acids, as well as cyclodopa glucoside derivatives (Kujala, Loponen and Pihlaja, 2001).

The antioxidant activity of different fruit peels and seeds were assayed on the basis of improved ABTS (free radical scavenging capacity) radical cation decolorization assay with some modifications incorporated (Duda-Chodak and Tarko 2007). Antioxidants are known for their capacity to avoid the injury caused by free radicals. (Blomhoff *et al*., 2006). Apple and grape pomace are rich in proanthocyanidins and flavonoids, banana in catechin and gallocatechin, carrot pomace in hydroxycinnamic derivatives like chlorogenic acid and dicaffeoylquinic acids (Zhang and Hamauzu, 2004), mango seed kernels (Puravankara, Boghra and Sharma, 2000) and mango peels (Larrauri, Ruperez and Saura-Calixto, 1996) in gallic and ellagic acids.

The polyphenolic compounds exhibit anti-cancer, anti-microbial (pathogens), anti-oxidative and immune-modulatory effects in vertebrates. The peel and pulp of guava fruits could be used as a source of antioxidant dietary fibre (Jimenez-Escrig *et al.,* 2001). Beet root peel is a potential source of valuable water-soluble nitrogenous pigments, called betalains, which comprise two main groups, the red betacyanins and the yellow betaxanthins. They are free radical scavengers and prevent active oxygen-induced and free radical-mediated oxidation of biological molecules (Pedreno and Escribano, 2001). Betalains have been extensively used as natural colorants in the modern food industry (Azeredo, 2009).

Pine apple waste, citrus peel juice has also been used to generate single cell protein using *Fusarium*. Potato peels supplemented with ammonium chloride have also been used for the production of protein by using a non-toxic fungi *Pleurotus ostreatus*. Similarly, waste from orange, sugarcane and grape processing industry have also been utilized for the production of single cell protein (Gautam and Guleria, 2007). Fruit wastes rich in carbohydrate content and other basic nutrients could support microbial growth and hence can be utilized for the production of single cell protein (Adoki, 2008). The nutritional worth of Banana Peels (BP), Musk Melon peels (MMP) and Water Melon Peels (WMP) revealed that MMP had the highest ($P<0.05$) cytoplasm and cell wall constituents, except cellulose which was highest in BP (Bakshi and Wadhwa, 2013).

Significant amount of carbohydrates is present in the fruit peels and hence they can be utilized as a source of carbohydrates. Carbohydrate concentration was also seen highest in pomegranate peels in the studies of Rowayshed *et al*., (2013) but guava is found to have even more amounts of carbohydrates than pomegranate. Banana and orange peels also contain significant amounts of carbohydrates as estimated by Anhwange *et al*., (2009) and Osarumwense *et al*., (2013) respectively.

Banana peels are known to contain a substantial amount of protein, lipid, carbohydrate, fiber and a number of essential minerals such as potassium, sodium, calcium, iron and manganese (Ahnwange, 2008). It was reported earlier by Essien *et al*., (2005) that banana peels could be processed as a mycological medium for growing valuable micro-fungal biomass, enriching the protein and fatty acid contents of the solid mixture. Banana peels are rich in trace elements, but Fe, Cu and Zn contents are much higher than the maximum tolerance limit for ruminants. Green peels have approximately 15 per cent starch which gets converted to sugars as the fruit ripens and the ripened peel has approximately 30 per cent free sugars. Tannins mostly present in the peels are responsible for the astringent taste of immature fruits, which adversely affect their palatability in monogastric animals, while there is no palatability problem with peels of the mature/ripened fruit. Ripening causes migration of tannins to the pulp or they get degraded by polyphenol oxidases and peroxidases (Emaga *et al.,* 2007).

Banana peels are widely used by small, marginal and landless farmers as complementary feeds for ruminants in the tropics. Their nutritive value is similar to that of cassava or citrus peels. Dairy cows fed 14−21 kg of fresh ripe banana peels increased milk production (Dormond, Boschini and Rojas, 1998). In grass-fed Zebus, the addition of 15−30 per cent banana peels in the diet increased weight gain significantly without causing health problems or affecting palatability (Botero *et al*., 2000). In goats, dry ripe plantain peels can replace up to 100 percent maize without adversely affecting growth performance and were found to be an economical source of carbohydrates (Aregheore, 1998).

Dried banana peels incorporated up to 10 per cent in broiler diets improved the live weight gain and feed conversion efficiency and beyond 10 per cent in the diet depressed the growth (Ulep and Santos, 1995). Sun dried ripe plantain peels could replace 75−100 per cent of maize in weaned rabbit diets with positive economic returns. Inclusion rates beyond 30 per cent in the diet adversely affected daily weight gain and feed conversion efficiency (Fanimo and Odu, 2006). The peels and seeds of many fruits can be considered as a potential source of different antioxidant components, which are not exploited at the moment, but could find practical application in many industrial branches (Chodak *et al.,* 2007).

Singh *et al.,* 2014 revealed that pomegranate peels due to its high antioxidant activity and phenolic content may prove to be a better substitute in place of synthetic antioxidants in extending the shelf life of food product by preventing the peroxide formation in the product containing fat and oil. Mango peel contains many of the same nutrients as the flesh and some of them are in even higher quantities than the main "meat" of the fruit. Peel of mango contain higher amount of carbohydrates, sugar and vitamin A, C, fiber and phytonutrients (www.doctorshealthpress.com).

Cucumber peels are a hidden source of beta-carotene, a type of vitamin A. Beta-carotene is well known for its beneficial effects on eye health and vision. Cucumber peels are rich in insoluble fiber, women need 25 g of total fiber daily, and men require 38 g, explains the Linus Pauling Institute. Peel have an beneficial effect to relieve constipation. Potato skin contains B vitamins, vitamin C, iron, calcium, potassium and other nutrients. Potato skin also provides lots of fiber, about 2 grams per ounce (www.livestrong.com).

Córdova *et al*., (2005), showed that functional properties of the passion fruit peel, especially those related to the content and type of fiber. The peel of passion fruit is rich in fiber, minerals, and especially pectin. Pectin is a fraction of soluble fiber in the gastrointestinal tract that forms a gel preventing the absorption of some nutrients. In the case of diabetes, it prevents the absorption of carbohydrates and can thus control and reduce the blood sugar rate (Ravi, 2005).

The antibacterial activity of the potato peel was found to be species dependent and the water extract of potato peel was effective only at high concentration against gram negative and gram positive bacteria (Sotillo *et al*., 2008). Prasad *et al*., 2007 investigated the extract of potato peel as antimicrobial agent against different types of bacteria and fungi. The results indicated the antibacterial and antifungal activities of potato peel to be species independent and when compared to one of antibiotics, streptocycline, potato peel had significant effect against *Pseudomonas aeruginosa* and *Clavibacter michigenensis*. In addition to its antimicrobial properties, potato peel can also function as a metal binder, probably due to its contents of polyphenolic compounds.

Potato peel, a natural antioxidant in food system, has higher content of polyphenols, i.e. 10 times higher than that in the flesh (Malmberg *et al*., 2004) accounting for approximately 50 % of all polyphenols in potato tuber (Friedman *et al*., 2007). The major phenolic acids present in potato peel gallic acid, caffeic acid, chlorogenic acid and protocatechuic acid. An experimental pro oxidant system was used to induce lipid peroxidation in rat Red Blood Cells (RBCs) and human RBC membranes. Potato peel was found to inhibit lipid peroxidation with similar effectiveness in both the systems (Schieber *et al*., 2001).

iii . Drying as a method of preservation

Drying is an ancient process used to preserve foods. Conventional drying (hot air) offers dehydrated products that can have an extended life of an year. Unfortunately, the quality of a conventionally dried product is drastically reduced from that of the original foodstuff. Freeze-drying is based on the dehydration by sublimation of a frozen product (Ratti, 2001)

Mujumdar 2008 reported that drying is highly energy consuming unit operation and competes with distillation as the most energy-intensive unit operation due to the high latent heat of vaporization of water and the inherent inefficiency of using hot air as the (most common) drying medium. Drying is one of the most cost-effective ways of preserving foods of all variety which involves removal of water by application of heat. A variety of food sub-types are preserved using drying, these include: marine products, meat products as well as all fruits and vegetables. Food products can have moisture content as high as 90% or more which needs to be reduced to an acceptable value so as to avoid microbial growth (Mujumdar *et al.*, 2008).

Dried fruits and other dried products are considered rich in energy, minerals and vitamins and are generally regarded as nutrient dense foods (Sablani, 2007). Protein, fat and carbohydrate is found in higher amount in the dried products than their fresh counterpart (Hawlader *et al*., 2006; Tripathy and kumar, 2009). Dehydrated vegetables are important foods consumed in most of the countries. In China, the production of dehydrated vegetables worth about US $ 800 million of which about 60-70 per cent (about 230000 Tonnes) are exported (Huang *et al.,* 2012). Roughly 34 per cent of the world's produce undergo artificial drying to improve keeping quality (Dev *et al*., 2012). Different drying methods are commercially available with different operating conditions, which may produce microstructural changes, in taste, aroma and colour losses and results in detrimental change of other quality characteristics (Reyes *et al*., 2011)

A food dehydrator is a small electrical appliance for drying food indoors. A food dehydrator has an electric element for heat and a fan, vents for air circulation. Dehydrators are efficiently designed to dry foods quickly at 140°F. Oven drying is slower than dehydrators because it does not have a built-in fan for the air movement. Dried vegetables have about half the shelf-life of fruits. (Judy *et al*., 2007). Zhang *et al*., (2009) showed that Microwave (MW)-related (MW-assisted or MW-enhanced) combination drying is a rapid dehydration technique that can be applied to specific foods, particularly to fruits and vegetables. Freeze drying is the best way to dehydrate most of the food products. Loss of volatiles is another important issue in drying of high valued fruits, spices, etc and needs to be handled properly but in a cost effective manner (Jangam *et al*, 2010).

Freeze drying is a low temperature vacuum drying technique. Freeze drying is one of the most sophisticated dehydration techniques. Freeze dried foods are generally considered as high quality food (Krokida *et al*., 2007). Freeze drying is a slow process and involve high investment and operating cost (Reyas *et al*., 2010). As freeze drying uses low temperature the biochemical and microbiological activities are regarded, which results in better quality of the final product (Dev *et al*., 2012).

Marchello (2010) examined that the freeze drying of a thin slab indicates that the rate of drying is dependent on the rate of heat transfer to the "dry-wet" interface and the mass transfer resistance offered by the porous dry layer to permeation of the vapour which sublimes from the interface. Because of the low pressures encountered in freeze drying, Knudsen diffusion may be significant. Chieh, (2006) revealed that temperature, moisture content and water activity are important physical factors in influencing the chemistry and biochemistry properties of food product during drying and storage. Water present in dehydrated foods is very important as it affects several deterioration reactions in food such as non- enzymatic browning, lipid oxidation, vitamin degradation, enzyme activity, microbial activity and pigment stability (Garcia and Wall, 2011).

Air convection drier is one of the most widely used methods of drying. Hot air drying uses air with elevated temperature to dry the products. A study done by Abascal *et al*., 2005 showed that oven drying at 30ºC did not caused a marked loss of volatile compound.

Sun drying is the oldest and most economical drying method. Energy consumption and dried product quality are critical parameters in the selection of drying process. Recently, due to increased prices and shortage of fossil fuels as well as of adverse impact on the environment, emphasis on the use of solar energy as an alternative energy source for dehydration (Tripathy and kumar, 2009).

Tasirin *et al* (2014) reported higher limonene in fluidized bed dried samples of orange peel compared to those of sun dried peels. Fluidized bed drying preserved 80 per cent of the vitamin C content whereas the sun drying preserved only 50 per cent of the total vitamin C. Velazquez *et al* (2014) studied sun drying with oven drying and reported that sun dried paprika were more associated with microbial proliferation and quality losses.

A study done by Henriquez *et al* (2012) showed that drum drying retained 30 per cent of the phenolics in apple peel. A study done by Rajchert *et al* (2015) showed that lyophilized cranberries has approximately 8 per cent higher anthocyanin pigment than those dried by convective fluidized bed drying. Increase in air drying temperature from 40 to 60ºC significantly reduced total phenolic and flavonoid content of lemon peel (Nesrine *et al*., 2015).

iv. Nutritional importance of millets

Suman *et al* (2013) reported that millets are the most drought resistant grains requiring little input for its production and are often considered to be “poor man’s cereal”. Millets are tiny, pale, yellow seeds with a nutty flavor which lends itself well to being cooked and eaten whole. With gradually increasing human population, millets are acquiring a status in the diet of health conscious consumers. In India, millets are the staple to a large selection of population residing in the semi-arid region.

Dykes *et al* (2007) said that coarse cereals can provide viable alternative to diversity sources of health components in foods, especially the benefits are highest for whole grain cereal consumption.

Kaur *et al* (2011) assessed the nutritional attributes of coarse cereals (millets) and also their utilization as food and as formulated foods. These cereals are laden with phytochemical including phenolic acids, tannins, anthocyanins, phytosterols and policosanols. Suman *et al* (2013) pointed out that, there is a growing demand for gluten-free foods and beverages for people with coeliac disease and other intolerance to wheat, which cannot eat products from wheat, barley or rye, to that millet has been established as the substitute. Verma *et al* (2013) observed that millets are the basic cereal in India and eaten by a large section of the poor community. Minor cereals consisting of maize, sorghum, pearl millet, finger millet and other millets constitute a little less than 25 per cent of the total food grain production in India. The nutritional composition of small millets compares well with other cereals and with regard to the nutrient content, some of them are even superior to rice and wheat.

Dayakar *et al* (2010) created awareness about jowar more than 20,000 consumers via in-mail promotions and road shows, which encouraged the entrepreneurs to launch jowar based foods. Popularization of millet based recipes was attempted by training the rural social groups through mid-day meal program and through the small-scale processors and potential entrepreneurs for marketing millet foods.

Padulosi *et al*., 2015 reported that Type 2 diabetes is a complex metabolic disorder associated with developing insulin resistance, impaired insulin signaling, beta cell dysfunction and abnormal glucose and lipid metabolism. These metabolic disorders lead to long-term pathogenic conditions including micro and macro-vascular complications, neuropathy, retinopathy and nephropathy. Millet has been shown to be potentially beneficial in the management of diabetes because of its high fiber content and slow digestion; moreover, it is a good source of B vitamins and contains substantial quantities of several minerals including calcium, iron, potassium and manganese. Millet is featured in healthy foods for its ability to decrease insulin resistance and the low risk of diabetes may be related to foods with high content of phytochemicals, high antioxidant capacity and polyphenolic compounds.

Studies concluded by Shukla *et al* (2011) reported that development of acceptable food products through the judicious uses of such foods and later on its commercialization may serve the people suffering from diabetes in an excellent way. There is tremendous opportunity to develop functional food targeted for those at risk for diabetes. The millet grains offer many opportunities for utilization in diversified products. Pearl millet (Bajra) has the highest content of macronutrients and micronutrients such as iron, zinc, Mg, P, folic acid and riboflavin. Finger millet (ragi) is an extraordinary source of calcium. Though low in fat content, it is high in PUFA (Polyunsaturated Fatty Acids) (Antony *et al.,* 2006). It is also rich in essential amino acids, like lysine, threonine, valine, sulphur containing amino acids and the ratio of leucine to isoleucine is about two (Ravindran, 1992; Antony *et al*., 2006, Indira and Naik, 2004). Malting finger millet reduces tannin content (brown millet) and phytate and improves ionisable iron and soluble zinc significantly. Malting of pearl millet and finger millet reduces protein content, but improves Protein Efficiency Ratio (PER), bioavailability and has pronounced effect in lowering anti-nutrients (Desai *et al*., 2010). Awika *et al*., 2004 said that sorghum is rich in phenolic compounds and antioxidants. Among minor millets, foxtail and barnyard millet have low glycaemic index (40-50).

Choi *et al*., (2005) and Park *et al*., (2008) reported that protein concentrate of Korean foxtail millet and proso millet significantly elevated plasma adiponectin and HDL cholesterol levels and caused major decreases in insulin levels relative to a casein diet in Type 2 diabetic mice. Furthermore, proso millet also improved glycemic responses and plasma levels (Park *et al*., 2008). In addition, proso millet protein concentrate has protective effects against D-galactosamin-induced liver injury in rats (Ito *et al*., 2008). Devi *et al*., (2011) reviewed the nature of polyphenols and dietary fiber of finger millet and their role with respect to the health benefits associated with millet. Veena, (2003) explained that the dietary fiber is an important photochemical component of barnyard millet (13% total dietary fiber with 4.66 and 8.18% of soluble and insoluble fractions, respectively) that could be considered in the management of disorders like diabetes mellitus, obesity, hyperlipidemia, etc.

v. Convenience foods in our daily life

People are affected by perceived time-scarcity, adopt “time-deepening” behavioral responses: speeding- up, shortening and substituting activities and multi-tasking (Godbey *et al*., 2010). Speeding-up food-related behavior means eating faster. Shortening activities include grazing to cut out time spent preparing and eating meals. Substituting a shorter activity for a longer one might include ordering takeaways or ready-meals in place of preparing a home-cooked meal. Multi-tasking includes eating while watching TV; driving; or working. While some people may use time management strategies and preserve conventional food and eating habits, most adapt eating behaviors to increase convenience and the marketing of convenience foods map onto these strategies. Convenience foods are becoming popular, and are defined "any fully or partially prepared food market" (Mahon *et al*., 2006). Convenience is as important as taste, "healthiness" and price in determining food-choices (Candel, 2001; Dave *et al*., 2009). However, convenience foods have been associated with less healthy diets, causing obesity and related chronic diseases such as cardiovascular disease, diabetes and cancer (Jabs and Devine, 2006).

Klopi *et al.,* (2013) said that convenience has been an ongoing trend for some time and will continue, but the speed will largely depend on the industry realizing that convenience means different things to different people and that there is a need for more products that combine convenience with healthiness and good sensory and culinary properties. Balasubramanian *et al.,* (2012) reported that rapid urbanization, industrialization and consequent changes in eating habits of people have lead to development of instant mixes and ready-to-eat convenience foods. Dry mixes of several traditional Indian foods such as idli mix, vada mix, kheer mix have gained worldwide popularity and popular choice of most of these products has been wheat and rice.

Increased consumption of ready-meals and fast-foods (Naska *et al*., 2011) can therefore be attributed to consumer's perceptions of time-scarcity, and a food industry ready to capitalize on opportunities to sell more (cheap) food with perceived added- value (convenience) at the maximum price the market will permit. This raises important issues for health promotion if such foods are energy-dense, high-fat foods associated with increased risks of obesity, diabetes and other chronic diseases (Jabs and Devine, 2006; WHO, 2002). Nutritional advice often focuses on what to eat, without matching recommendations to hectic lifestyles. Understanding how time-scarcity affects food-choices may lead to more realistic and useful strategies to promote healthy behaviours. By settling for convenience foods, consumers restrict their choices, compounding further the effect of poor cooking skills and dependence on a nutrient balance defined by manufacturers. By definition, "convenience foods" such as ready-meals are purchased by consumers without time to read detailed nutrient composition information. In some fields, food/catering industries have accepted some responsibility for impact of their products on health and make appropriate changes. For example, reduction in salt content was pioneered by a group of manufacturers (Neptune Project website). Much more could be done through minor recipe and menu modification, and examples of how to incorporate existing products into healthy, nutritionally-balanced meals.

Kowsalya and Indra (2010) reported that processed foods include convenient food like instant mixes, extruded foods, canned foods and dehydrated foods, extruded products and nutrient mixes have better shelf life and are easily acceptable by all age groups. An attempt has been made Banu *et al.,* (2012) to prepare the multigrain composite and its various functional, nutritional, anti-oxidant properties have been studied. These multigrain composite mixes have been used for the preparation of food formulations which finds use in the preparation of savory products, snacks, pan cake, snacks, like muruku etc. Research and development work carried out at CFTRI on processing and value addition to sorghum and millets has indicated the possibility of preparation of a new generation products (Meera *et al*., 2009)

Liu *et al.,* (2011) demonstrated the utility of extrusion processing in incorporating high levels of leafy vegetable ingredient in expanded snacks. The extruded product based on moringa leaf powder and oat flour, had substantially improved macro and micro nutrient profile as compared to commercially available snacks. These moringa leaf powder oat flour snacks had at least 20 and 90 per cent fiber and protein respectively, and also lower post coating fat and higher vitamin A, iron and calcium than a typical puffed commercial products. Singh *et al.,* (2012) found that finger millets up to 60 per cent can be successfully incorporated to formulate iron rich namakpar mixes. These mixes are low cost, nutritious, had good storage stability and were acceptable at both laboratory and field level. These mixes can be successfully used for supplementary programs. Pradeep *et al.,* (2013) revealed that popped sorghum, pearl millet and grain amaranthus can be mixed with expanded legumes to prepare a ready-to-eat snack mix. This mix can be shaped into either laddu, burfi or porridge form, mix contain adequate amount of protein and minerals and was found suitable for feeding children and also people of all age groups.

III. METHODOLOGY

The methodology of the present study entitled "**Development of RTE Millet Mixes with fruit and vegetable peel**" is dealt under the following two phases:

Phase I – Standardization of dehydration methods and nutrient analysis of fruit and vegetable peel

i. Selection and procurement of fruits and vegetables
ii. Selection and standardization of dehydration methods
iii. Nutrient analysis of fresh and dehydrated fruit and vegetable peels

Phase II- Development of RTE millet mixes using dehydrated fruit and vegetable peels

i. Selection of millets
ii. Selection of recipes
iii. Formulation of millet based RTE mix
iv. Incorporation of dehydrated peels into standardized RTE mix
v. Sensory evaluation of the dehydrated peel incorporated RTE mix
vi. Cost analysis of the RTE millet mix
vii. Statistical analysis and interpretation of the results

Phase I

Standardization of the dehydration methods and nutrient analysis of fruit and vegetable peel

i. Selection and procurement of fruits and vegetables

Fruits and vegetables are low fat and low energy dense foods, relatively rich in vitamins, minerals and other bioactive compounds and a good source of fibre. They are essential to maintain proper body functions (Dowell *et al.,* 2009). After a thorough study of the available reviews and literature on fruits and vegetables nutritive value, two fruits and two vegetables namely, banana (*Musa paradiaca*), grapes (*Vitis vinifera*), potato (*Solanum tuberosum*) and cucumber (*Cucumis sativus*) having more nutrients such as vitamins, minerals, fiber and phytochemicals-carotenoids, flavonoids, limonoids and polyphenols which appear to have biological activities and health benefits were selected for the present study. There is considerable evidence that these fruits and vegetables have antioxidant and antimutagenic properties and positive associations with bone and anti-cancer, antimicrobial, antiviral, cardioprotective, neuroprotective, hepatoprotective activities and immune system health (Zhang *et al*., 2005; Franch *et al.,* 2010; Jyoti *et al.,* 2014; Formica *et al*., 2014). Mature, ripe, fresh, intact fruits with no bruises namely banana and grapes, vegetables namely cucumber and potato were procured in bulk quantity from the pazhamudir nizhayam. Banana was washed under running tap water and the skin was peeled. The procured fruits namely, grapes was soaked in soft water for half an hour to remove the presence of any pesticide residue. The water was drained, washed again and peeled. Selected vegetables namely cucumber and potato were washed under running tap water thoroughly to remove the presence of mud and dust particles present on the upper layer of the skin. The skin was then peeled off using a peeler in a clean plate.

ii. Selection and standardization of dehydrated methods

Dehydration is an ancient process of preserving foods and removes the moisture from the product. Drying is one of the most cost-effective ways of preserving foods of all methods which involves removal of water by application of heat. It is a complex operation involving transient transfer of heat and mass along with several rate processes, such as physical or chemical transformations, which, in turn, may cause changes in product quality (Mujumdar *et al.*, 2008). Different methods of dehydration methods were used. In the present study, the dehydration methods selected include tray drying, microwave drying and sun drying. 500 g of fresh fruits and vegetables were taken for dehydration of samples. Selected vegetables namely potato, cucumber and fruit namely banana were washed thoroughly under running tap water to remove the presence of mud and dust particles present on the upper layer of the skin. The banana peels were removed manually by hand; cucumber and potato peel were removed using peeler. Grapes were soaked in soft water for half an hour to remove the presence of any pesticide residue, the soaked water was decanted, washed again and the skin was removed from the flesh of the grapes.

a. Tray drying

Tray drying or cabinet drying is a dehydration technique where dehydration of the sample is carried out at a low temperature under reduced pressure (Rahuramulu *et al*., 2003). Potato peels and cucumber peels were cut into pieces of 1.5 cm length and had thickness of 0.5mm. The four samples were kept in trays at a temperature of 50˚C. Potato and cucumber peels took 15 hours to dehydrate; whereas grape peel and banana peel took 20 hours to dehydrate. The color of the peels turned to a darker shade after dehydration (Plate 1).

b. Microwave drying

Microwave drying is a conventional method where heat is passed over the food sample which reduce the moisture content in food thereby drying the food. Potato, cucumber, grapes and banana peels were subjected to microwave drying. The temperature was maintained at 40ºC. The microwave oven was preheated for 6 minutes. Potato and cucumber peels took 24 minutes to get dehydrated; grapes 26 minutes and banana 46 minutes. The dehydrated fruit and vegetable peels were stored in air tight zip lock covers and labelled. The color of the microwave dried peels turned to a darker shade after dehydration (Plate 2).

c. Sun drying

Sun drying is one of the oldest method of drying and preservation techniques known to mankind. It is a slow and gentle drying technique which gives the product its characteristic taste, color and flavor. The process of sun drying depends on the intensity of the sunlight allows the product to reach optimum moisture and quality levels. Sun drying was done between 10 am to 3 pm. The fruits and vegetable peels were placed in clean plates and were covered using perforated polyethylene cover to prevent it from sweating. Cucumber and potato peels were cut into 1.5 cm length and dehydrated for 5 consecutive days. As grapes and banana peels are thick they took 7 days for drying. The temperature varied between 30ºC to 32ºC on these days. All the peels were dehydrated until the moisture content reduced to less than 10 per cent. Sun dried samples almost retained the same color compared to other two dehydration methods (Plate 3).

All the dehydration methods were standardized by altering the time and temperature and were done in triplicates.

Banana peel

Grapes peel

Potato peel

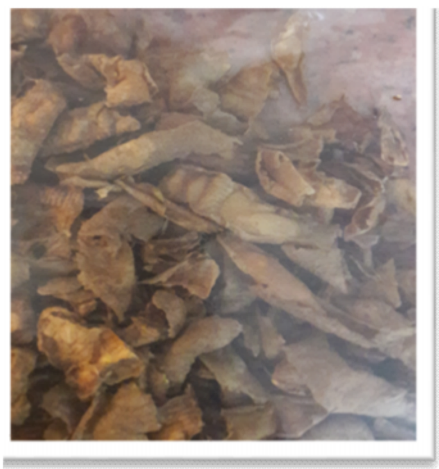
Cucumber peel

Plate 1

Tray dried fruit and vegetable peels

Banana peel

Grapes peel



Potato peel

Cucumber peel

Plate 2

Microwave dried fruit and vegetable peel

Banana peel

Grapes peel

Potato peel

Cucumber peel

Plate 3

Sun dried fruit and vegetable peel

iii. Nutrient analysis of fresh and dehydrated fruit and vegetable peel

The nutrient analysis was carried out for all the fresh and dehydrated fruit and vegetable peels. The nutrients analyzed include both macro and micro nutrients. The macro nutrients analyzed include carbohydrate, protein, fat, ash and micronutrients analyzed include calcium, iron, vitamin C and vitamin A. The nutrient analysis was carried out using the standard procedures of AOAC methods (1990).

Carbohydrate estimation of the fresh and dehydrated peel was done using Anthrone method. The amount of protein present was estimated using Macrokjeldhal's method. The amount of fat was estimated using soxhlet apparatus. The iron and vitamin A content was estimated using colorimetric method. Vitamin C was estimated using dye method and calcium using titrimetric method and calcium was determined using precipitating mthod. (AOAC, 1990) (Plate 4).

Nutrient analysis was done for all the fresh and dehydrated fruit and vegetable peels in triplicates. The nutrient content of dehydrated fruit and vegetable peels were compared with the fresh peel. From this, it was observed that the nutrient content of the tray dried samples were comparable to the nutrient content of fresh peels when compared to other dried methods. Hence, tray dried fruit and vegetable peels were used for incorporating into the RTE (Ready To Eat) mix.

iii.a. Analysis of anti-nutritional substances in selected fruit and vegetable peels

Anti-nutrients are substances that are damaging to health, they include metals such as lead, calcium and mercury, their presence in the body uses up large amount of nutrients such as zinc, calcium, vitamin and other anti-oxidants to neutralize them. Phytic acid is an anti-nutrient that interferes with the absorption of minerals from the diet (Beecher, 2003). (Appendix I).

The tray dried fruit and vegetable peels had maximum retention of nutrients. Hence, these tray dried dehydrated peels were chosen for incorporating into the RTE mix. Also tray dried fruit and vegetable peels were analyzed for the presence of anti-nutritional factor namely phytic acid.

Ashing

Calcium estimation

Nitrogen estimation

Iron estimation

Organoleptic evaluation

Plate 4

Nutrient analysis of fresh and dehydrated fruit and vegetable peel and organoleptic evaluation

Phase-II

Development of RTE millet mixes using dehydrated fruit and vegetable peels.

i. Selection of millets

Millets have great potential for being utilized in different food systems by virtue of their nutritional quality and economic importance. Millets are nutritious food and are rich in phytochemicals, fiber and minerals (Nazneen *et al.*, 2012). Based on the nutritional importance of millets, four millets rich in nutrients were selected for the present study. The selected millet grains were procured from super market and cleaned to separate sand grits and other heavy particles. They are stored in air tight containers for further use. The four millets selected for the study is presented in Table I.

Table I

Local name, botanical name and other names of the selected millets

Local name	Botanical name	Other names
Cholam	*Sorghum bicolor*	Jowar, Jowari, Juar, Jola, Jondhala, Juara, Jona
Kuthiraivali	*Echinochooa colona*	Shyama, Sanwa, Oodalu, Khira, Swank, Udalu, Kodisama.
Thinai	*Setaria itallica*	Kaon, Kang, Kakum, Navane Kang, Rala, Kanghu, Kangam, Kora, Kangni, Korra.
Samai	*Panicum sumatrense*	Sama, Gajro, Kuri, Kutki, Shaven, Sava, Halvi, Vari, Suan, Samalu.

ii. Selection of Recipes

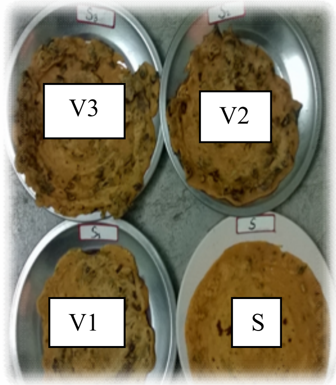
In India 3+2 food pattern is followed. i.e. three heavy meals and two snacks. Hence three recipes one each from breakfast, lunch and dinner was selected for the study. The recipe for breakfast includes adai, for lunch vegetable pulav and for dinner chappati. All these recipes were standardized by altering the quantity of ingredients used in the formula. To the standardized recipe, the tray dried dehydrated peels were incorporated at three levels. Based on the type of recipe selected and the texture of the mix, millets were either brokened or powdered and sieved. For adai mix, coarse powder and for chappati mix, millet grains were used in the form of powder. The powder was sieved in a 40 mesh sieve of 0.42mm and was incorporated into the chappati mix. For vegetable pulav, millet grains were cleaned and used as such.

iii. Formulation of millet based RTE mix

The RTE mixes for the three commonly consumed recipes namely adai, vegetable pulav and chappati were standardized. The procedure for recipe preparation in the study was standardized based on the procedure followed by RCT (Ramaswamy Chinnammal Trust) food industry in Coimbatore. To prepare RTE millet mix, weighed quantities of the ingredients were taken, dry roasted the ingredients separately in a pan, for a stipulated time and mixed. The mix was allowed to cool. The method i.e. the time taken for roasting the ingredients was standardized. The quantity of the ingredients used and the method of preparation of recipes are outlined in Appendix II. The recipes were standardized by altering the quantity of ingredients in the standard recipe such that the dehydrated peels blends into the mix.

iv. Incorporation of dehydrated fruit and vegetable peels into standardized RTE mix

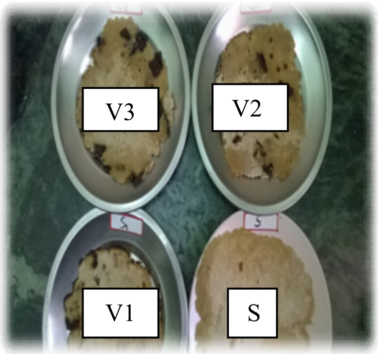
The dehydrated fruit and vegetable peels were incorporated into the standardized RTE millet mix in varying proportions. The dehydrated fruit and vegetable peels were incorporated at three levels namely, 5, 10 and 15 per cent into the developed RTE millet mix. The tray dried peels were powdered and added into the RTE chappati mix, as coarse powder into RTE adai mix and as whole millet grains into the RTE vegetable pulav mix. Standard I contains 5g of dehydrated peel and 95g of millet mix; standard II contains 10g of dehydrated peel and 90g of millet mix and standard III contains 15g of dehydrated peel and 85g of millet mix. All the developed RTE mixes were standardized and used for sensory evaluation (Plate 5 to 8).



Adai with tray dried banana peel

vegetable pulav with

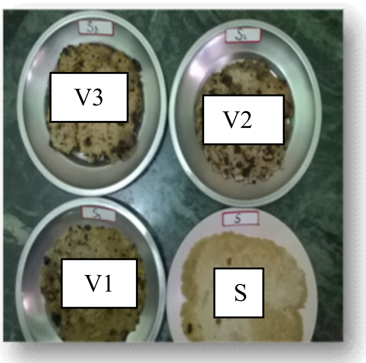
tray dried banana peel



Chappati with tray dried banana peel

Adai with tray dried grapes peel

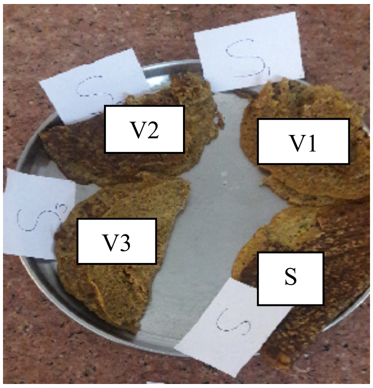
Vegetable pulav with tray dried grapes peel



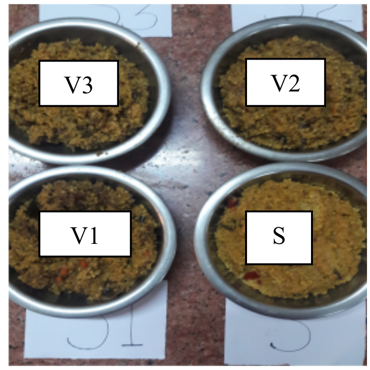
Chappati with tray dried grpes peel

Plate 5

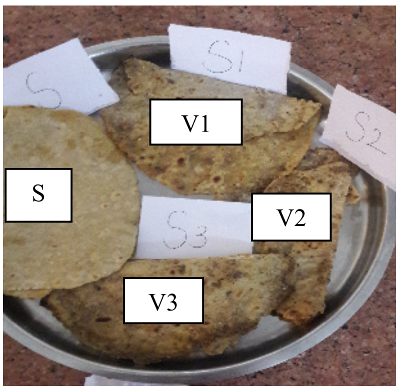
Recipes prepared from tray dried banana and grapes peel



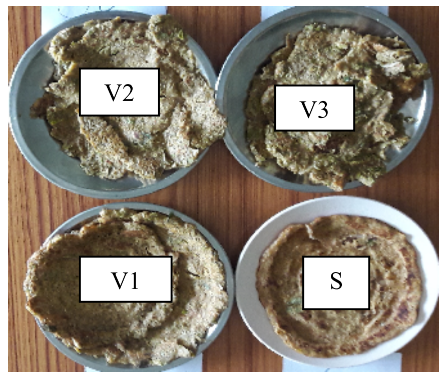
Adai with tray dried potato peel



Vegetable pulav with tray dried potato peel

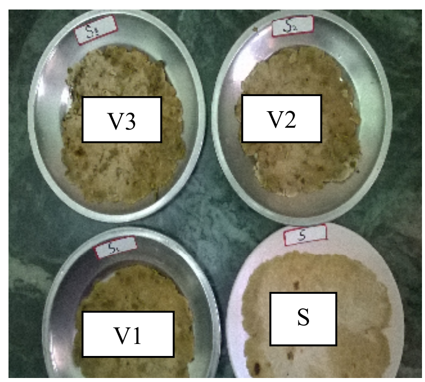


Chappati with tray dried potato peel



Adai with tray dried cucumber peel

Vegetable pulav with tray dried cucumber peel



Chappati with tray dried cucumber peel

Plate 6

Recipes prepared from tray dried potato and cucumber peel

v. Sensory Evaluation of the dehydrated peel incorporated RTE mix

Sensory Evaluation is defined as "A scientific discipline used to evoke, measure, analyze, and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste and hearing" (Stone and Sidel, 1993). The fruit and vegetable peel incorporated RTE millet mix were evaluated sensorily. Twenty semi trained panelists doing post-graduation in either Food Science and Nutrition or Food Service Management and Dietetics of Avinashilingam university were selected for sensory evaluation. Sensory evaluation was carried out using 9 point hedonic scale for all the sensory characteristics namely appearance, flavor, texture, taste, color and overall acceptability. Scoring 9 to 0 corresponds to from like very much to dislike very much. The prepared recipes were analyzed sensorily after the class hours i.e. at 3.30pm (Plate 4). The score card for sensory evaluation of the recipes is given in Appendix IV.

vi. Statistical analysis and interpretation of the results

The data obtained for sensory attributes of the developed recipes with three variations was analyzed statistically and interpreted. The data was consolidated and tabulated in which mean and standard deviation were computed.

The research design and the protocol used in the study was submitted for scrutinisation and approval to the Institutional Human Ethics Committee and ethical clearance approval was obtained. The Ref. No. is AUW/IHEC/FSN-15-16/XMT-06 (Appendix IV).

The methodology followed in the present study is represented in Figure 1 and 2

PHASE - I

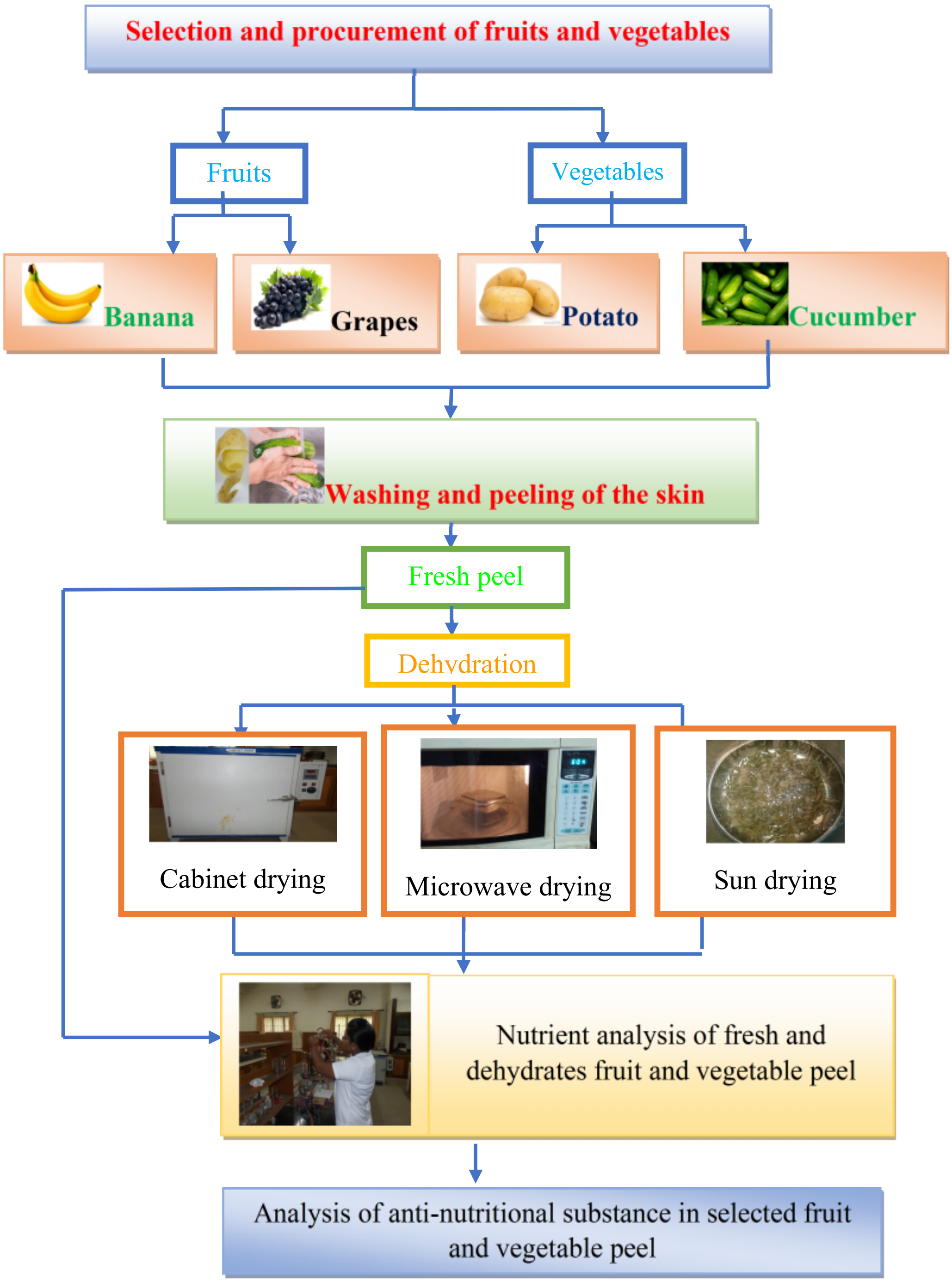


Figure 1
Standardization of the dehydration methods and nutrient analysis of fruit and vegetable peel

PHASE-II

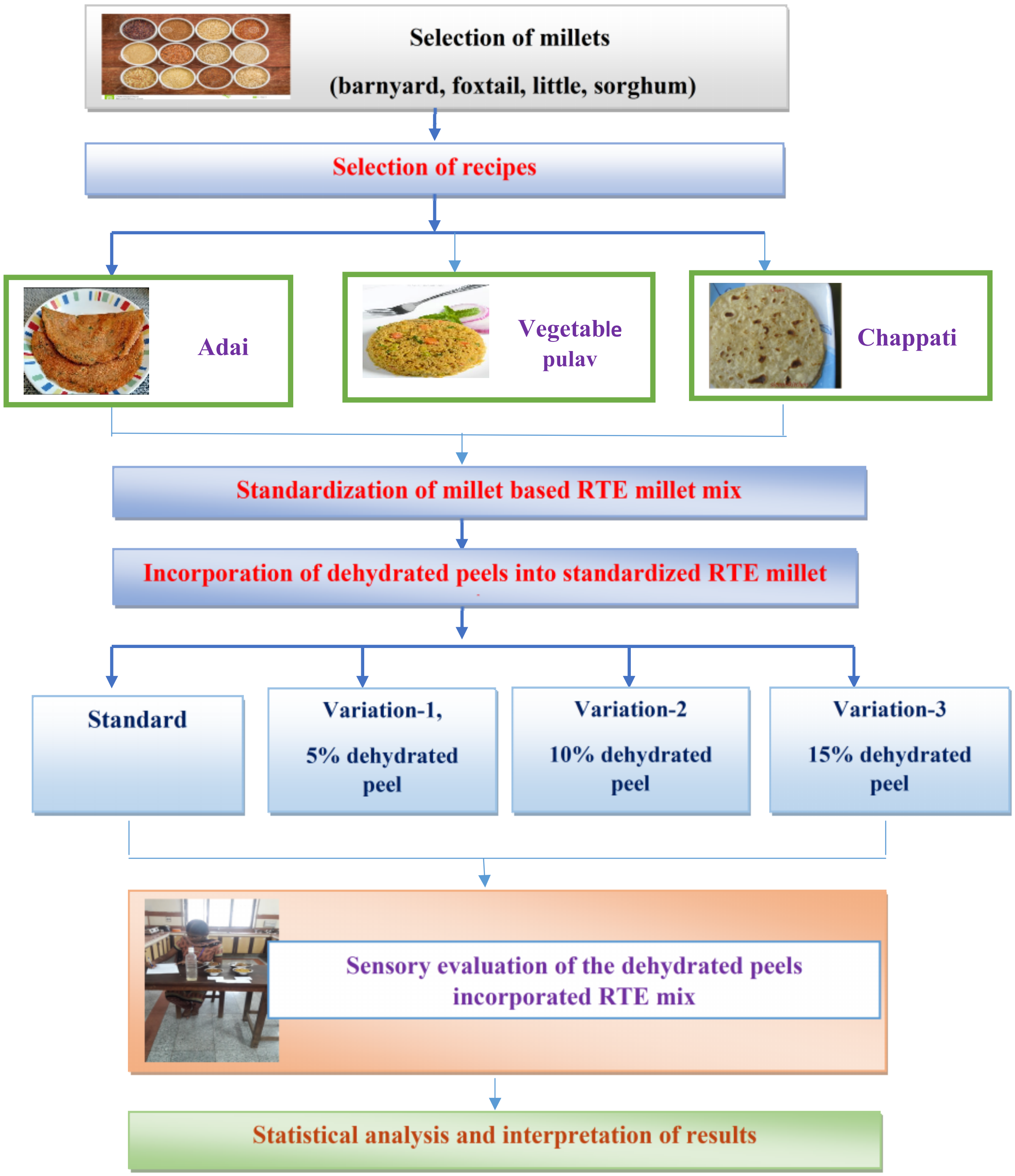


Figure 2

Development of the RTE millet mix using dehydrated fruit and vegetable peel

IV. RESULTS AND DISCUSSION

The results pertaining to the study "**Development of RTE millet mixes with fruit and vegetable peel**" is presented under the following headings:

i. Dehydration characteristics of the selected fruit and vegetable peels
ii. Nutrient content of fresh and dehydrated fruit and vegetable peels
iii. Organoleptic evaluation of the developed RTE millet recipes incorporated with tray dried peel powder
iv. Cost analysis of the developed RTE millet mix

i. Dehydration characteristics of the selected fruit and vegetable peels

The fruits and vegetables selected namely banana, grapes, potato and cucumber were dehydrated using three dehydration methods, namely tray drying, microwave drying and sun drying to a residual moisture content below 10 per cent. The duration and temperature of drying are among the most important factors which affect the physical, chemical, microbiological and nutritional characteristics of the dehydrated products. Table II shows the weight of the fresh fruits and vegetables and the weight of the fruit and vegetable peels, from 500g of the sample.

TABLE II

Weight of the fresh fruits and vegetables and their peels

Fruits / vegetables	Weight of the sample (g)	Weight of the peels (g)
Banana	500	146
Grapes	500	214
Potato	500	100
Cucumber	500	75

Five hundred grams of the fresh fruit and vegetable peels were taken each for dehydration techniques. Weight of the banana peel from 500g of fruit was 146 g; grapes peel was 214 g; potato was 100 g and cucumber was 75 g. It was seen that the peel quantity of the selected fruits and vegetables differ with each variety because of the thickness of the peel. Temperature and time are the important factors in dehydration techniques. The temperature, time required for drying the peel and weight of the dehydrated peels is given in Table III.

TABLE III

Temperature, time and weight of the dehydrated peels

Tray Drying Temperature: 50˚C			
Fruit/vegetable	**Time (hours)**	**Weight (g)**	
		Fresh peel	**Dehydrated peel**
Banana	20	146	10
Grapes	20	214	14.5
Potato	15	100	9
Cucumber	15	75	8
Microwave Drying Temperature 40˚C			
Fruits /vegetables	**Time (minutes)**	**Weight (g)**	
		Fresh peel	**Dehydrated peel**
Banana	46	146	20
Grapes	26	214	16
Potato	24	100	18
Cucumber	24	75	9
Sun drying Temperature: 30˚C to 32˚C; Time: 11 am to 3.30 pm			
Fruits/vegetables	**Time (hours)**	**Weight (g)**	
		Fresh peel	**Dehydrated peel**
Banana	28	146	15.6
Grapes	28	214	16.1
Potato	20	100	23.5
Cucumber	20	75	15

Tray drying took 20 hours for dehydrating banana peel and grapes peel. From 146 g of the fresh banana peel, 10 g of dehydrated peel and from 214 g of fresh grapes peel 14.5 g of dehydrated peel was obtained. Potato and cucumber dehydrated in 15 hours, dehydrated weight of the potato peel was 9 g and for cucumber peel 8g from 100 and 75 g of fresh peel respectively.

It was seen that microwave drying took least time to dehydrate when the temperature was maintained at 40˚C for all selected fruit and vegetable peels. Banana peel dehydrated in 46 minutes; grapes peel in 26 minutes and potato and cucumber each dehydrated in 24 minutes and the final moisture content in the microwave dried sample was seen to be below 10 per cent. Weight of the dehydrated peels was weighed and obtained. 20 g of banana peel; 16 g of grapes peel; 18 g of potato peel and 9 of cucumber peel was obtained after dehydration.

The drying time taken for sun drying of each sample was longest. Banana and grapes peel dehydrated in 28 hours because of the high moisture content and dehydration of potato and cucumber peels in 20 hours. Dehydrated weight of the banana peel was 15.6 g; grapes peel was 16.1 g; whereas potato peel was 23.5 g and cucumber peel was 15g. Kowsalya and Vidhya (2004) also reported similar findings where drying green leafy vegetables using sun drying took longer time to dry compared to tray drying. In the present study also, sun drying took longer time for dehydration compared to other methods.

From the dehydration methods adopted, it can be observed that the weight of the dehydrated peel was least in cucumber peel with 8, 9 and 15g for tray, microwave and sun drying respectively from 75g of the peel. It means that more moisture content is seen in cucumber peel compared with grapes, banana and potato. The color of the peels turned to a darker shade after dehydration.

ii. Nutrient content of fresh and dehydrated fruit and vegetable peels

Dehydration causes changes in the nutrient content of the product. However, the degree of changes depend largely on the dehydration techniques and treatments given. Fresh peels of banana, grapes, potato and cucumber and the peels dehydrated using tray drying, microwave drying and sun drying were subjected to nutrient analysis. The nutrient content of fresh, tray, microwave and sun dried peels are given in Tables IV, V, VI and VII.

ii.a. Nutrient content of banana peel

Table IV reveals the nutrient content of the fresh and dehydrated banana peel.

TABLE IV

Nutrient content of fresh and dehydrated banana peel

Method of drying	Carbohydrate (g)	Protein (g)	Fat (g)	Fiber (g)	Calcium (mg)	Iron (mg)	Vitamin C (mg)	Vitamin A (µg)
Fresh	24.0	3.5	1.65	3.03	19.00	1.10	10.1	50.00
Tray drying	20.0	3.15	1.53	2.90	17.00	1.10	9.00	47.30
Microwave drying	18.3	2.9	1.20	2.10	14.50	1.00	7.50	43.00
Sun drying	15.0	2.0	1.00	1.90	11.00	0.30	5.00	39.00

The carbohydrate content of fresh banana peel was 24 g, tray dried 20 g, microwave dried 18.3g and sun dried 15.00 g respectively. The protein content of fresh banana peel was 3.5 g, for tray drying 3.15g, for microwave drying and sun drying the protein content was 2.9 g and 2g respectively. The fat content was 1.65g for fresh peel; 1.53 g for tray dried peel; 1.2 g for microwave dried peel and one gram for sun dried peel. Fiber present in fresh peel was 3.03 g; tray dried peel was 2.9 g; microwave dried peel was 2.1 g and sun dried banana peel was 1.9g. Vitamins and minerals which were analyzed include calcium, iron, vitamin C and vitamin A. Calcium content in fresh peel was 19 mg whereas tray dried peel had 17 mg of calcium. Fourteen mg of calcium was present in microwave dried peel and 11mg in sun dried peel. The iron content of fresh and tray dried banana peel was 1.1 mg; one mg and 0.3 mg was present in microwave dried and sun dried banana peel. Vitamin C present in fresh peel was 10.1mg followed by 9 mg in tray dried peel; 7.5 mg in microwave dried peel and 5 mg in sun dried banana peel. 50 µg of vitamin A was present in fresh peel whereas tray, microwave and sun dried banana peel had 47.3 µg, 43 µg and 39 µg respectively. It was observed that tray dried banana peels had maximum retention of nutrients compared to other dehydration methods.

ii.b. Nutrient content of grapes peel

Table V shows the nutritive value of fresh and dehydrated grapes peel.

TABLE V

Nutritive value of fresh and dehydrated grapes peel

Method of drying	Carbohydrate (g)	Protein (g)	Fat (g)	Fiber (g)	Calcium (mg)	Iron (mg)	Vitamin C (mg)	Vitamin A (µg)
Fresh	17.00	0.63	0.15	0.70	10.00	0.3	9.00	35.00
Tray drying	15.60	0.50	0.12	0.60	8.00	0.26	7.00	33.00
Microwave drying	11.70	0.27	0.07	0.45	5.00	0.22	5.10	27.00
Sun drying	9.30	0.10	0.04	0.10	4.00	0.15	3.00	23.00

The carbohydrate, protein, fat and fiber content of fresh grapes peel found to be 17 g, 0.63g, 0.15g and 0.70g respectively. The minerals such as calcium and iron present in fresh peel was 10.00mg and 0.30mg. Vitamin C and A was found to be 9 mg and 35µg in fresh grapes peel. Tray dried grapes peel contain 15.60g of carbohydrate; 0.50g of protein; 0.12g of fat;0.60g fiber; 8mg of calcium; 0.26mg of iron; 7mg of vitamin C and 33µg of vitamin A. The microwave dried grapes peel had 11.70g of carbohydrate; 0.27g of protein; 0.07g of fat; 0.45g of fiber; 5.00mg of calcium; 0.22mg of iron; 5.10mg of vitamin C and 27µg of vitamin A. Sun dried grapes peel had 9.3g of carbohydrate; 0.1g of protein; 0.04g of fat; 0.1g of fiber; 4mg of calcium; 0.15mg of iron; 3mg of vitamin C and 23µg of vitamin A. Tray dried grapes peel had maximum retention of nutrients which was closest to that of the fresh grapes peel revealing that tray dried grapes peel retained more nutrients.

ii.c. Nutrient content of potato peel

Table VI gives the amount of nutrients present in fresh and dehydrated potato peel.

TABLE VI

Nutrient content of fresh and dehydrated potato peel

Method of drying	Carbohydrate (g)	Protein (g)	Fat (g)	Fiber (g)	Calcium (mg)	Iron (mg)	Vitamin C (mg)	Vitamin A (µg)
Fresh	33.70	3.50	3.50	4.00	19.00	1.00	19.00	32.00
Tray drying	32.70	2.90	3.10	3.60	15.30	1.00	17.00	29.00
Microwave drying	28.00	2.20	2.90	2.90	10.00	0.80	12.00	22.00
Sun drying	23.50	1.90	2.00	2.10	8.00	0.40	10.00	18.00

The fresh potato peel had 33.70g of carbohydrate; 3.50g of protein; 3.50g of fat; 4g of fiber; 19mg of calcium; one mg of iron; 19mg of vitamin C and 32µg of vitamin A. The tray dried potato peel had 32.7g of carbohydrate; 2.90g of protein; 3.10g of fat; 3.60g of fiber; 15.30mg of calcium; one mg of iron; 17mg of vitamin C and 29µg of vitamin A. Compared to fresh peel, the microwave dried potato peel had 28g of carbohydrate; 2.2g of protein; 2.90g each of fat and fiber; 10mg of calcium; 0.80mg of iron; 12mg of vitamin C and 22µg of vitamin A. When compared to fresh and other two types of dehydration techniques, sun dried grapes peel had low nutritive value with carbohydrate 23.5g; protein 1.9g; fat 2g; fiber 2.10g; calcium 8mg; iron 0.40mg; vitamin C 10mg and vitamin A 18µg. Dehydrated potato peel revealed that the maximum nutrient retention was in tray dried samples and minimum in sun dried samples.

ii.d. Nutrient content of cucumber peel

The nutrient content of fresh and dehydrated cucumber peel is depicted in Table VII.

TABLE VII

Nutrient content of fresh and dehydrated cucumber peel

Method of drying	Carbohydrate (g)	Protein (g)	Fat (g)	Fiber (g)	Calcium (mg)	Iron (mg)	Vitamin-C (mg)	Vitamin-A (µg)
Fresh	3.50	0.60	0.11	0.45	16.00	0.20	2.5	52.00
Tray drying	2.90	0.49	0.90	0.30	15.00	0.19	2.1	49.50
Microwave drying	2.30	0.30	0.40	0.25	12.00	0.12	1.9	43.00
Sun drying	1.90	0.29	0.20	0.20	9.00	0.10	1.00	40.00

Carbohydrate content of fresh cucumber peel was 3.5g followed by protein 0.60g; fat 0.11g; fiber 0.45g; calcium 16.00mg; iron 0.20mg; vitamin C 2.50mg and vitamin A 52µg. When compared to fresh peel the nutritive value of the tray dried cucumber peel was decreased. It had a carbohydrate content of 2.90g; protein 0.49g; fat 0.90g; fiber 0.30g; calcium 15.00mg; iron 0.19mg; vitamin C 2.10mg and vitamin A 49.5µg. Microwave dried cucumber peel had 2.30g of carbohydrate; 0.30g of protein; 0.40g of fat; 0.25g of fiber; 12mg of calcium; 0.12mg of iron; 1.9mg of vitamin C and 43µg of vitamin A. Sun dried cucumber peel had low amount of nutrients compared to fresh and other two dehydration methods. Carbohydrate, protein, fat and fiber was found to be 1.90g, 0.29g, 0.2g and 0.2g respectively along with calcium, iron, vitamin C, vitamin A with 9mg, 0.1mg, 1mg and 40µg respectively. From the values obtained, it is clear that tray dried cucumber peel had maximum retention of nutrients followed by microwave and sun dried samples. Also the nutrient content of tray dried samples was comparable with the fresh cucumber peels.

ii.e. Anti-nutritional substance in dehydrated fruit and vegetable peels

Anti-nutrients are substances that cause damage to health. They include metals such as lead, calcium and mercury. In this study anti-nutritional substance namely phytic acid present in selected dehydrated fruits and vegetables was analyzed. Phytic acid is an anti-nutrient that interferes with the absorption of minerals from diet (Shi *et al*., 2009). Phytic acid content of tray dried fruit and vegetable peels is given in Table VIII and Figure 3.

TABLE VIII

Phytic acid content in tray dried fruit and vegetable peel

Tray dried fruit and vegetable peels	Upper limit (mg)	Phytic acid mg/100g
Banana	24	12
Grapes	23	18
Potato	37	39
Cucumber	20	10

The peels of tray dried samples of fruits and vegetables had maximum retention of nutrients. Hence anti-nutritional substance namely phytic acid was analyzed only for tray dried samples. It was seen that potato had high amount i.e.39 mg of phytic acid per 100g of dehydrated peels. This was followed by grapes peel with 18 mg; banana peel with 12 mg and cucumber peel with 10 mg. Phytic acid content was higher in tray dried potato peel and least in tray dried cucumber peel. The safe upper limit of phytic acid was found to be 24 mg, 23 mg, 37 mg and 20 mg for banana, grapes, potato and cucumber respectively. The values obtained in the present study are safe within the upper limits and hence can be incorporated in the RTE mix.

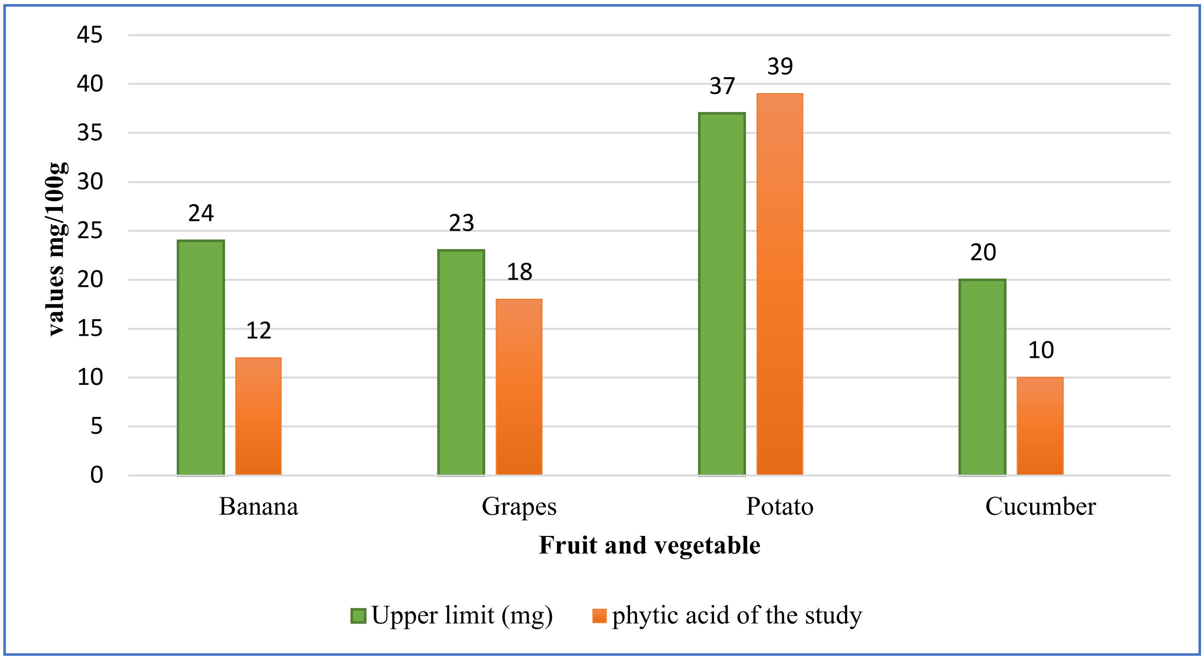


Figure 3

Phytic acid content in tray dried fruit and vegetable peel

iii. Organoleptic evaluation of the developed RTE millet recipes incorporated with tray dried peel powder

Texture is a primary attribute that, together with visual appearance, taste and aroma, comprises the sensory quality of foods. The only way to evaluate sensory quality or some of its attributes is to ask their opinion, since sensory quality is not an intrinsic food characteristic, but the result of interactions between humankind and food. The analysis of the chemical composition and the physical properties of a certain food product affords information about the nature of stimuli perceived by the consumer, but not about the sensation experienced in its consumption (Brandt *et al*., 2003).

Three popular, traditional recipes which were consumed regularly in the normal diet were selected for the incorporation of dehydrated fruit and vegetable peels. The recipes that were one recipe each from breakfast, lunch and dinner namely adai, vegetable pulav and chappati were selected for inclusion of dehydrated peels. These recipes are easy to prepare and are either protein, fiber or energy rich. All the recipes were incorporated with tray dried peels. An incorporation level of 5 per cent, 10 per cent and 15 per cent, were chosen each for adai, vegetable pulav and chappati. Acceptability of the food is also an important criteria in any situation. Therefore, acceptability trials of the developed recipes were done. The developed recipes were subjected to sensory evaluation by 20 semi trained panelists. The various parameters based on which the recipes were tested by panelists was appearance, color, taste, flavor and texture. A nine point hedonic scale was chosen for the evaluation. The overall acceptability for each recipe was assessed by considering the different criteria for sensory evaluation.

iii.a. Organoleptic evaluation of RTE adai incorporated with tray dried banana peel

Table IX and Figure 4 picturises the organoleptic evaluation of millet adai incorporated with tray dried banana peel.

TABLE IX

Organoleptic evaluation of adai prepared from RTE millet mix incorporated with tray dried banana peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	8.10 ± 0.72	8.10 ± 0.64	8.10 ± 0.72	7.40 ± 0.82
Color	8.10 ± 0.72	8.25 ± 0.84	7.65 ± 0.59	6.80 ± 0.62
Taste	8.45 ± 0.60	8.50 ± 0.51	7.40 ± 0.75	6.80 ± 0.77
Flavor	8.40 ± 0.68	8.60 ± 0.50	7.50 ± 0.61	6.90 ± 0.64
Texture	8.10 ± 0.64	8.00 ± 0.56	7.30 ± 0.57	6.95 ± 0.76
Over all acceptability	8.50 ± 0.61	8.20 ± 0.62	7.40 ± 0.88	6.80 ± 0.89

Organoleptic evaluation of RTE millet adai incorporated with banana peel revealed that the appearance for standard, variation 1 and 2 was 8.1 and for variation 3, 7.4. The mean values obtained for color was 8.10 for standard, 8.25 for variation 1, 7.65 for variation 2 and 6.8 for variation 3. The taste of variation 3 was maximum with 8.5 followed by 8.45 for standard, 7.4 for variation 2 and 6.8 for variation 3. The flavor of variation 1 was highest with 8.6 whereas it was 8.4 for standard. This was followed by 7.5 for variation 2 and 6.9 for variation 3. The mean scores for texture was 8.1, 8.7, 7.3 and 6.95 for standard, variation 1, variation 2 and variation 3 respectively.

The overall acceptability of the RTE millet adai mix revealed that variation 1 had a maximum score of 8.2 and was comparable with the standard of 8.5.

iii.b. Organoleptic evaluation of RTE vegetable pulav incorporated with tray dried banana peel

Table X and Figure 5 shows the organoleptic evaluation of millet vegetable pulav incorporated with tray dried banana peel.

TABLE X

Organoleptic evaluation of vegetable pulav prepared from RTE millet mix incorporated with tray dried banana peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	8.00 ± 0.46	8.15 ± 0.59	8.15 ± 0.93	6.70 ± 0.92
Color	8.15 ± 0.67	8.35 ± 0.59	7.90 ± 0.85	6.80 ± 0.62
Taste	8.15 ± 0.81	8.35 ± 0.75	8.10 ± 0.74	6.70 ± 0.57
Flavor	8.20 ± 0.70	7.70 ± 0.80	8.00 ± 0.45	6.60 ± 0.60
Texture	8.10 ± 0.72	7.90 ± 0.85	8.05 ± 0.52	6.95 ± 0.76
Over all acceptability	8.05 ± 0.60	8.25 ± 0.64	8.15 ± 0.93	6.80 ± 0.70

Vegetable pulav incorporated with tray dried banana peel powder, prepared from standard and variations 1, 2 and 3 showed that in terms of appearance, scores a mean value of 8.15 for variation 1 and 2, 8 for standard and 6.70 for variation 3. In terms of color, standard and three variations got scores between 6.80 to 8.35.Variation 1 scored maximum mean value of 8.35 followed by standard - 8.15, variation2 -7.90 and variation 3 – 6.80. Taste contributed scores from 6.70 to 8.35. The maximum mean value is obtained for variation 1 with mean value of 8.35, standard with 8.15, variation 2 with 8.10 and variation 3 with 6.70. The scores obtained for flavor in vegetable pulav with dehydrated banana peel ranged from 6.60 to 8.20, the maximum score obtained for standard with mean value of 8.20 followed by variation 2 with 8, variation 1 with 7.70 and variation 3 with 6.60. With regard to texture standard showed the best result with mean value of 8.10 followed by mean scores of 8.05, 7.9 and 6.95 for variation 2, variation 1 and standard respectively.

In terms of scores obtained for overall acceptability standard obtained 8.05 scores followed by variation 1 with 8.25, variation 2 with 8.15 and variation 3 with 6.80.

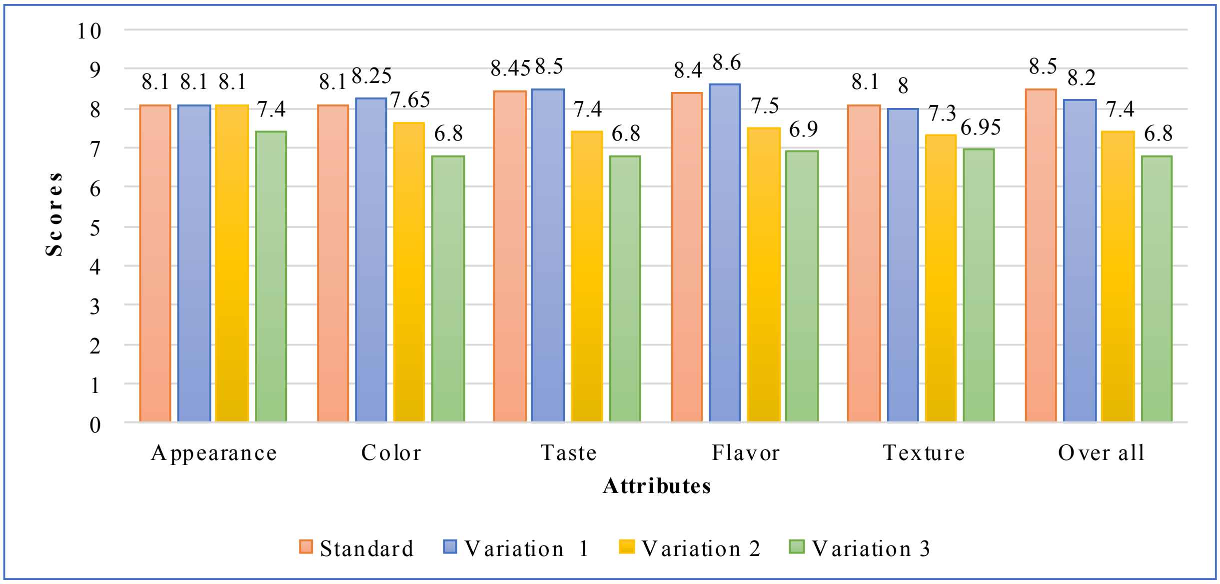


Figure 4

RTE millet adai incorporated with tray dried banana peel

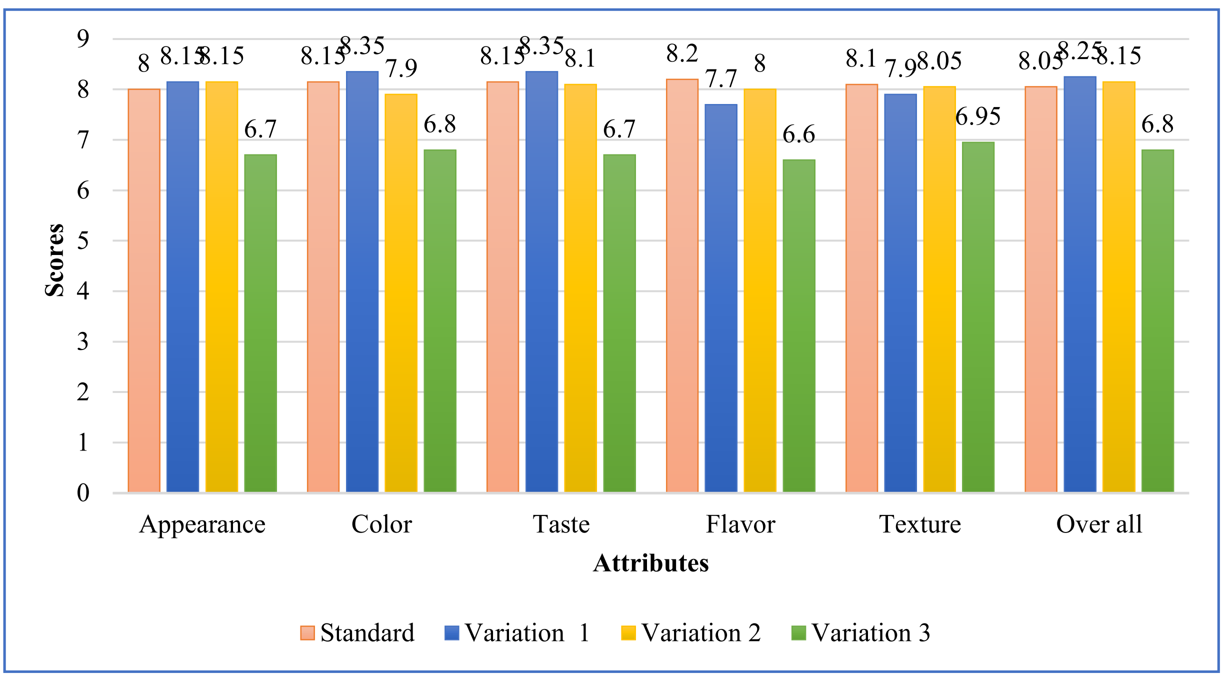


Figure 5

RTE millet vegetable pulav incorporated with tray dried banana peel

iii.c. Organoleptic evaluation of RTE chappati incorporated with tray dried banana peel

Table XI and Figure 6 presents the organoleptic evaluation of millet chappati incorporated with tray dried banana peel.

TABLE XI

Organoleptic evaluation of chappati prepared from RTE millet mix incorporated with tray dried banana peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	7.75 ± 0.64	7.45 ± 0.94	6.80 ± 0.89	6.65 ± 0.81
Color	7.90 ± 0.45	6.70 ± 0.73	6.70 ± 0.98	6.50 ± 0.61
Taste	7.65 ± 0.67	5.90 ± 0.64	6.10 ± 0.64	6.45 ± 0.94
Flavor	7.75 ± 0.64	6.95 ± 0.75	6.65 ± 0.84	6.20 ± 0.70
Texture	7.75 ± 0.79	7.25 ± 0.64	6.40 ± 0.88	6.10 ± 0.85
Over all acceptability	7.70 ± 0.80	7.15 ± 0.84	6.75 ± 0.85	6.40 ± 0.88

The appearance of chappati prepared with tray dried banana peel powder was 7.75 for standard, 7.45 for variation 1, 6.80 for variation 2 and 6.65 for variation 3. The mean value of color for standard was 7.90, variation 1 and variation 2 was 6.70 and variation 3 was 6.50. The values obtained for taste was maximum in standard with 7.65 followed by variation 3 with 6.45, variation 2 with 6.10 and variation 1 with 5.90. The scores for flavor ranged between 7.75 to 6.20. The maximum mean value was obtained for standard with a mean value of 7.75 followed by variation 1 with 6.95, variation 2 with 6.65 and variation 3 with 6.20. The mean values were 7.75, 7.25, 6.40 and 6.10 for standard, variation 1, variation 2 and variation 3 for texture. In terms of overall acceptability, standard scored 7.70, variation 1 scored 7.15, variation 2 scored 6.75 and variation 3 scored 6.40 respectively.

iii.d. Organoleptic evaluation of RTE adai incorporated with tray dried grapes peel

Table XII and Figure 7 represents the organoleptic evaluation of millet adai prepared with tray dried grape peel.

TABLE XII

Organoleptic evaluation of adai prepared from RTE millet mix incorporated with tray dried grapes peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	8.35 ± 0.49	8.34 ± 0.60	6.75 ± 0.55	6.55 ± 0.51
Color	8.45 ± 0.51	8.50 ± 0.51	6.90 ± 0.79	6.65 ± 0.49
Taste	8.40 ± 0.50	8.45 ± 0.60	6.90 ± 0.64	6.60 ± 0.50
Flavor	8.65 ± 0.49	8.42 ± 0.51	7.20 ± 0.77	6.10 ± 0.64
Texture	8. 35 ± 0.67	8.30 ± 0.47	6.60 ± 0.50	6.50 ± 0.51
Over all acceptability	8.40 ± 0.50	8.45 ± 0.51	7.10 ± 0.72	6.55 ± 0.51

From the results, it is evident that the mean score value for appearance of standard was 8.35, variation 1 was 8.34, variation 2 was 6.75 and variation 3 was 6.55 for adai incorporated with tray dried grapes peel. The score for color ranged from 6.65 to 8.50. The maximum score obtained for variation 1 was 8.50 followed by standard with 8.45, variation 2 with 6.90 and variation 3 with 6.65. The mean scores for the taste of standard was 8.40, variation 1 was 8.45, variation 2 was 6.90 and variation 3 was 6.60. The flavor of the standard observed a mean score of 8.65, variation 1 with 8.42, variation 2 with 7.20 and variation 3 with 6.10. With regard to texture, standard, variation 1, variation 2 and variation 3 got mean scores of 8.35, 8.30, 6.60 and 6.50 respectively. The scores obtained for over all acceptability of variation 1 with incorporation of 10 per cent got mean value of 8.45 followed by standard with 8.40, variation 2 with 7.10 and variation 3 with 6.55 respectively.

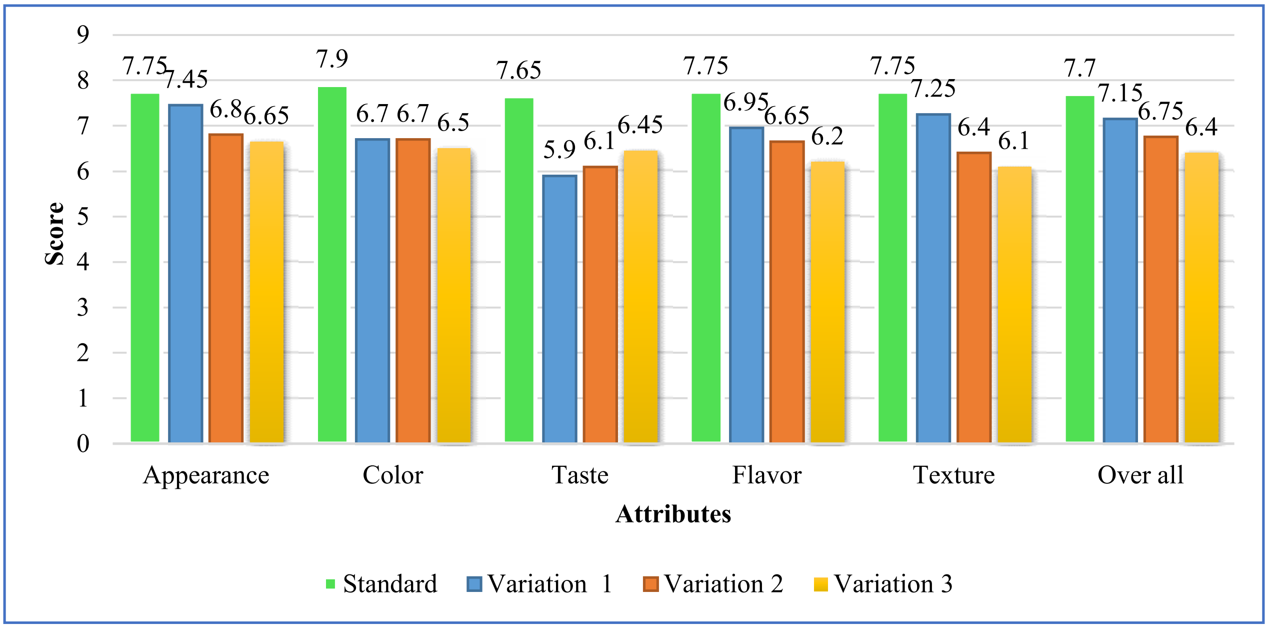


Figure 6

RTE millet chappati incorporated with tray dried banana peel

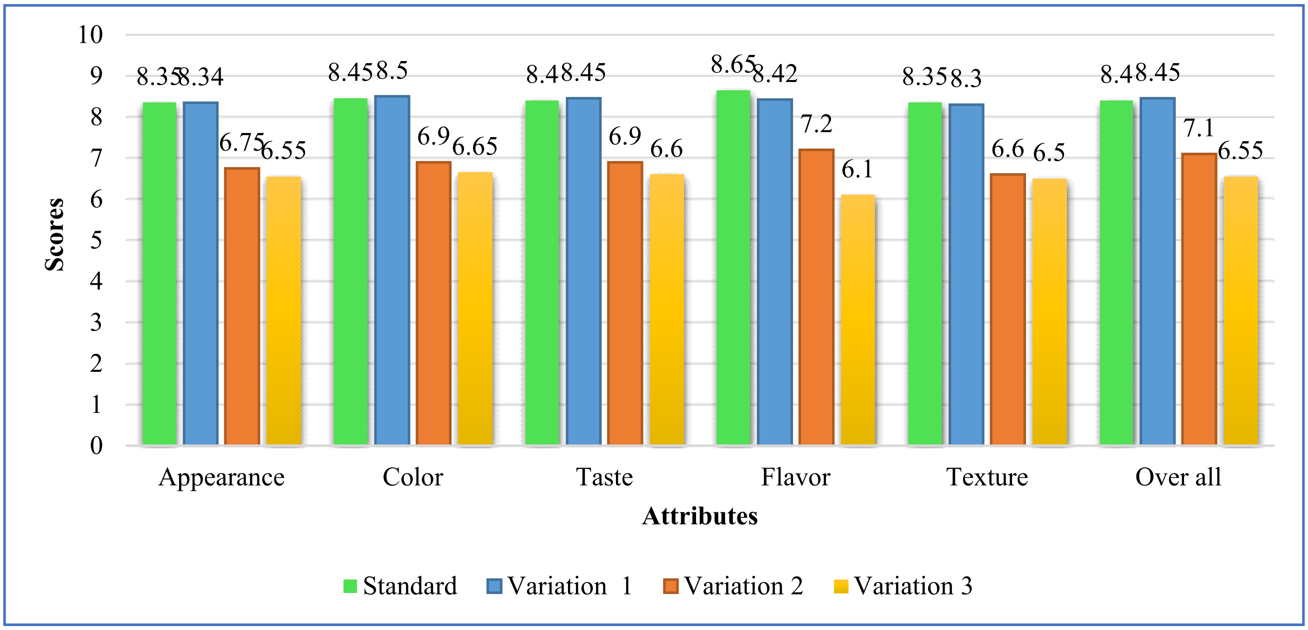


Figure 7

RTE millet adai incorporated with tray dried banana peel

iii.e. Organoleptic evaluation of RTE vegetable pulav incorporated with tray dried grapes peel

Table XIII and Figure 8 depicts the organoleptic evaluation of millet vegetable pulav prepared with tray dried grapes peel.

TABLE XIII

Organoleptic evaluation of vegetable pulav prepared from RTE millet mix incorporated with tray dried grapes peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	8.15 ± 0.59	8.60 ± 0.50	7.05 ± 0.60	6.60 ± 0.50
Color	8.40 ± 0.50	8.55 ± 0.51	6.50 ± 0.51	6.55 ± 0.51
Taste	8.35 ± 0.59	8.30 ± 0.47	6.90 ± 0.72	7.20 ± 0.62
Flavor	8.30 ± 0.57	8.50 ± 0.51	7.15 ± 0.81	6.70 ± 0.47
Texture	8.25 ± 0.64	8.17 ± 0.43	6.70 ± 0.57	7.20 ± 0.52
Over all acceptability	8.45 ± 0.51	8.45 ± 0.63	6.65 ± 0.49	6.50 ± 0.51

The standard vegetable pulav prepared from tray dried grape peel and variations 1, 2 and 3 showed that in terms of appearance, variation 1 i.e. 5 per cent incorporation scored best result with mean value of 8.60. Variation 3 scored least value of 6.60 and standard and variation 2 score mean values of 8.15 and 7.05 respectively. In terms of color, the minimum score obtained was variation 2 with mean value of 6.50 followed by variation 3 with 6.55, standard with 8.40 and variation 2 with 8.55 respectively. The mean values for taste of standard was 8.35, variation 1 was 8.30, variation 2 was 6.90 and variation 3 with 7.20. The scores for flavor was 8.30 for standard, 8.50 for variation 1, 7.15 for variation 2 and 6.70 for variation 3 correspondingly. Texture obtained a mean value of 8.25 for standard, 8.17 for variation 1, 6.70 for variation 2 and 7.20 for variation 3. The overall acceptability for standard and variation 1 was 8.45, variation 2 was 6.65 and variation 3 was 6.50 respectively.

iii.f. Organoleptic evaluation of RTE chappati incorporated with tray dried grapes peel

Table XIV and Figure 9 represents the organoleptic evaluation of millet chappti prepared with tray dried grapes peel.

TABLE XIV

Organoleptic evaluation of chappati prepared from RTE millet mix incorporated with tray dried grapes peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	7.85 ± 0.59	6.20 ± 0.89	6.20 ± 0.53	5.95 ± 0.94
Color	7.20 ± 0.62	6.60 ± 0.99	5.80 ± 0.65	6.30 ± 0.83
Taste	6.80 ± 0.83	6.70 ± 0.92	5.20 ± 0.70	5.30 ± 0.75
Flavor	7.35 ± 0.59	6.65 ± 0.75	5.05 ± 0. 76	6.10 ± 0.56
Texture	7.20 ± 0.70	5.60 ± 0.88	5.56 ± 0.81	5.60 ± 0.53
Over all acceptability	7.40 ± 0.60	5.75 ± 0.91	5.50 ± 0.54	5.65 ± 0.63

From the above table, it is clear that the appearance of standard was maximum with mean value of 7.85 followed by variation 1 and 2 with 6.20 and variation 3 with 5.95 for chappati incorporated with tray dried grapes peel powder. Color contributes scores from 7.20 to 6.30. The maximum mean score obtained for standard with 7.2. In terms of taste and flavor standard got mean value of 6.80 and 7.35 respectively, variation 1 got 6.70 and 6.65 respectively variation 2 got 5.20 and 5.05 respectively and variation 3 got 5.30 and 6.10 respectively. Texture of standard, variation 1, variation 2 and variation 3 secured a mean values of 7.20, 5.60, 5.56 and 5.60 correspondingly. Over all acceptability of standard was 7.40, variation 1 was 5.75, variation 2 was 5.50 and variation was 5.65.

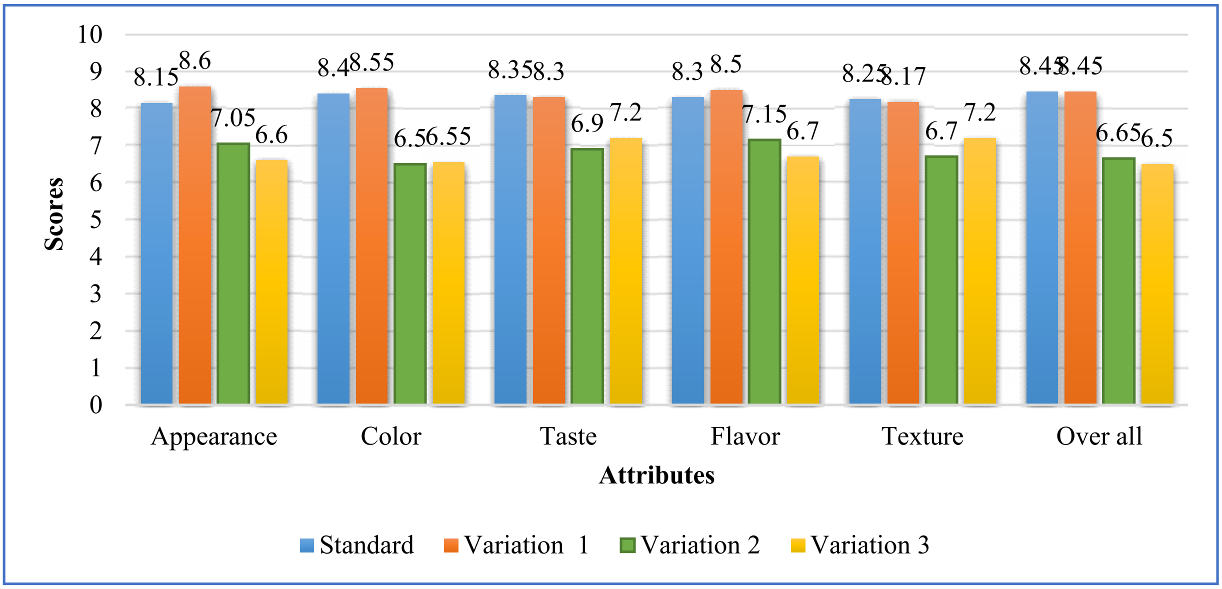


Figure 8

RTE millet vegetable pulav incorporated with tray dried grapes peel

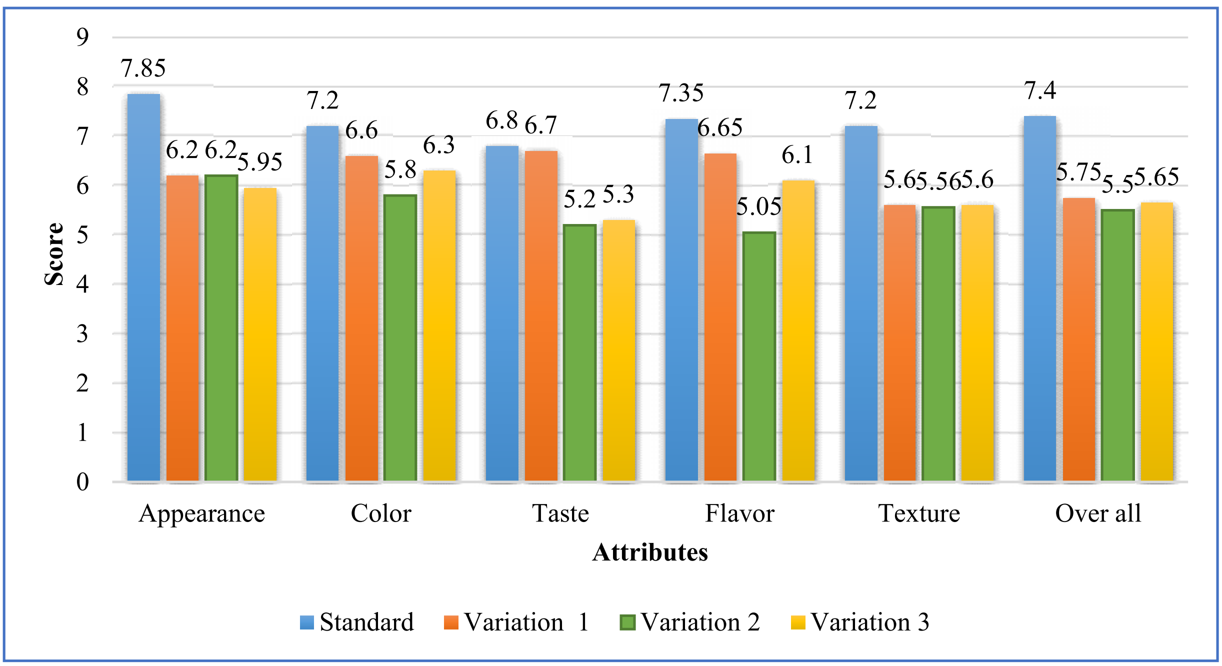


Figure 9

RTE millet chappati incorporated with tray dried grapes peel

iii.g. Organoleptic evaluation of RTE adai incorporated with tray dried potato peel

Table XV and Figure 10 shows the organoleptic evaluation of millet adai prepared with tray dried potato peel.

TABLE XV

Organoleptic evaluation of adai prepared from RTE millet mix incorporated with tray dried potato peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	8.20 ± 0.72	8.10 ± 0.64	8.10 ± 0.72	7.40 ± 0.82
Color	8.10 ± 0.62	8. 3 ± 0.69	7.65 ± 0.59	6.80 ± 0.62
Taste	8.45 ± 0.60	8.50 ± 0.51	7.40 ± 0.75	6.80 ± 0.77
Flavor	8.40 ± 0.68	8.60 ± 0.50	7.50 ± 0.61	6.90 ± 0.64
Texture	8.10 ± 0.64	8.00 ± 0.56	7.30 ± 0.57	6.95 ± 0.76
Over all acceptability	8.50 ± 0.61	8.20 ± 0.62	7.40 ± 0.88	6.80 ± 0.89

Adai prepared from standard and variations 1, 2 and 3 incorporated with tray dried potato peel showed that in terms of appearance, variation 1 and 2 have no significant difference. Standard and variation 3 had a decreased value of 8.2 and 7.4 respectively. In terms of color, standard and three variations got scores between 6.80 to 8.10. Standard had maximum score of 8.10. Taste as an important attribute contribute scores from 6.80 to 8.45. The maximum mean value obtained was for variation 1 with 8.5. The scores obtained for flavor in adai ranged from 6.90 to 8.60, the maximum obtained for variation 1 with 8.60. With regard to texture standard showed the best score with mean value of 8.10. In terms of scores obtained for overall acceptability standard obtained scores 8.50 followed by variation 1 with 8.20, variation 2 with 7.40 and variation 3 with 6.80.

iii.h. Organoleptic evaluation of RTE vegetable pulav incorporated with tray dried potato peel

Table XVI and Figure 11 depicts the organoleptic evaluation of millet vegetable pulav prepared with tray dried potato peel.

TABLE XVI

Organoleptic evaluation of vegetable pulav prepared from RTE millet mix incorporated with tray dried potato peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	8.20 ± 0.52	7.45 ± 0.94	6.85 ± 0.93	6.65 ± 0.81
Color	7.80 ± 0.52	6.70 ± 0.73	6.70 ± 0.98	6.55 ± 0.69
Taste	7.60 ± 0.60	5.95 ± 0.76	6.10 ± 0.93	6.55 ± 0.52
Flavor	7.65 ± 0.67	6.05 ± 0.10	6.65 ± 0.95	6.30 ± 0.80
Texture	7.70 ± 0.80	7.35 ± 0.75	6.50 ± 0.95	6.10 ± 0.79
Over all acceptability	7.65 ± 0.81	7.00 ± 0.26	6.70 ± 0.92	6.40 ± 0.88

From the above table, it was found that the appearance of vegetable pulav prepared from tray dried potato peel standard and variations 1, 2 and 3. Standard scored best result with mean value of 8.20. Variation 3 scored a decreased score of 6.65. In terms of color, standard and three variations got scores between 6.55 to 7.80.Variation 1 and 2 had mean value of 6.70 each. The maximum mean score for color was for standard with 7.8. Taste contributes scores from 5.95 to 7.60. The maximum mean value obtained for standard was 7.60 followed by variation 3 with 6.55, variation 2 with 6.10 and variation 1 with 5.95. The scores obtained for flavor ranged from 6.05 to 7.65, the minimum score 6.05 for variation 1, 6.30 for variation 3, 6.65 for variation 2 and 7.65 for standard. With regard to texture, standard showed the best result with mean value of 7.70 followed by variation 1 with 7.35, variation 2 with 6.50 and variation 3 with 6.10 respectively. Overall acceptability of standard obtained was 7.65 followed by variation 1 with 7.00, variation 2 with 6.70 and variation 3 with 6.40.

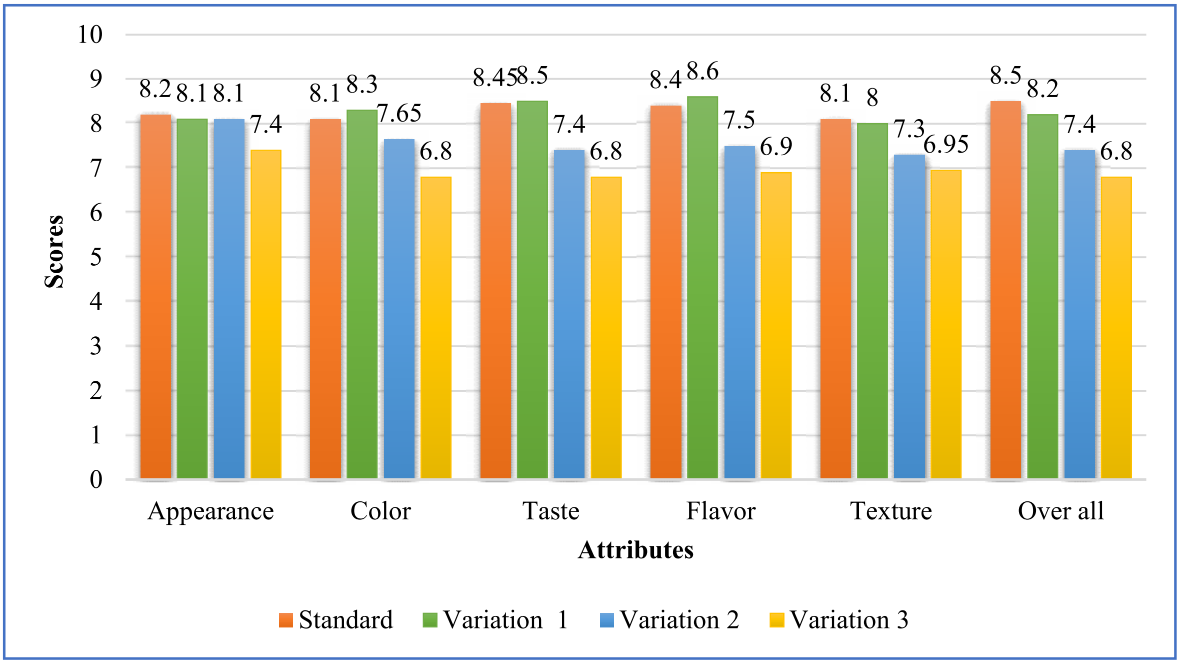


Figure 10

RTE millet adai incorporated with tray dried potato peel

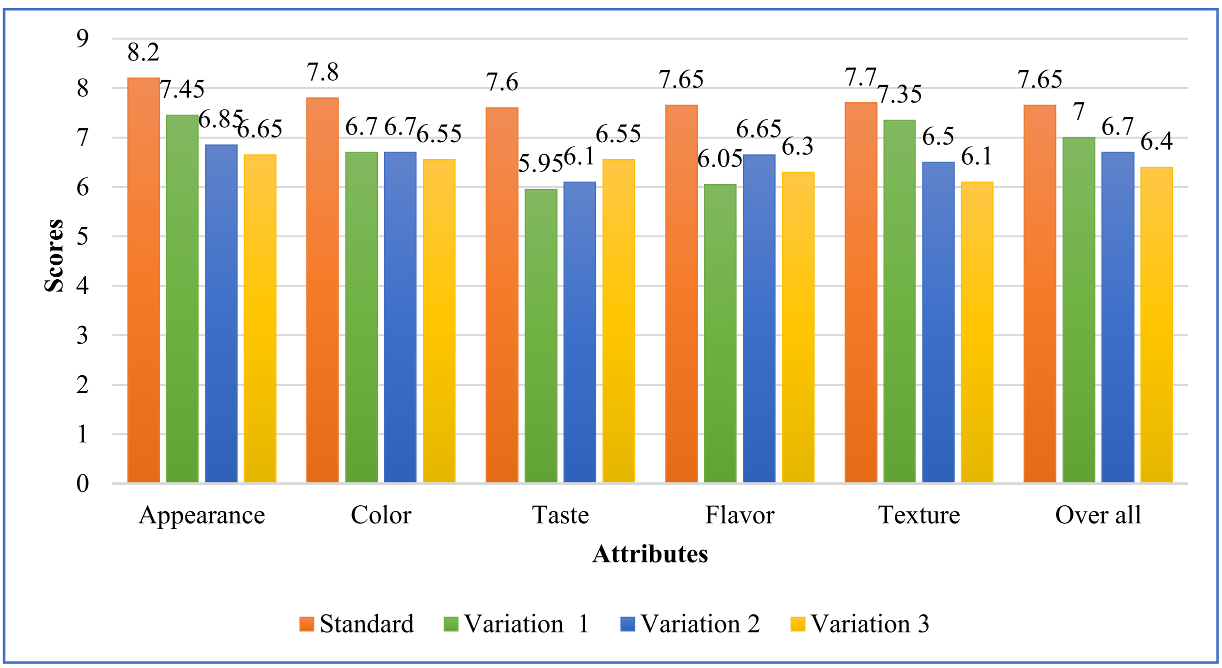


Figure 11

RTE millet vegetable pulav incorporated with tray dried potato peel

iii. i. Organoleptic evaluation of RTE chappati incorporated with tray dried potato peel

Table XVII and Figure 12 showed organoleptic evaluation of millet chappati prepared with tray dried potato peel.

TABLE XVII

Organoleptic evaluation of chppati prepared from RTE millet mix incorporated with tray dried potato peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	7.95 ± 0.60	6.90 ± 0.79	7.40 ± 0.95	7.20 ± 0.95
Color	7.25 ± 0.79	7.45 ± 0.89	7.60 ± 0.68	6.95 ± 0.78
Taste	7.65 ± 0.67	6.60 ± 0.60	6.80 ± 0.83	6.60 ± 0.82
Flavor	7.55 ± 0.60	6.90 ± 0.85	6.60 ± 0.60	6.90 ± 0.83
Texture	6.90 ± 0.72	7.15 ± 0. 84	7.00 ± 0.92	6.10 ± 0.91
Over all acceptability	7.90 ± 0.85	7.05 ± 0.94	7.20 ± 0.89	6.10 ± 0.71

Regarding to the appearance of chappati prepared with tray dried potato peel, the score was 7.95 for standard; 6.90 for variation 1; 7.40 for variation 2 and 7.20 for variation 3. Color contributes scores from 6.95 to 7.45. The maximum mean value was 7.60 obtained for variation 2 followed by 7.45 for variation 1, 7.25 for standard and 6.95 for variation 3. The minimum mean value obtained was 6.60 for variation 1 and 3, 6.80 for variation 2 and 7.65 for standard for taste respectively. In terms flavor, variation 2 got 6.60 the least, variation 1 and 3 got 6.90, standard got 7.55 respectively. Texture ranged from 6.10 to 7.15. Variation 1 with 5 per cent incorporation got maximum mean value of 7.15 followed by variation 2 with 7, standard with 6.90 and variation 3 with 6.10. The mean values obtained for overall acceptability of standard was 7.90, variation 1 with 7.05, variation 2 with 7.20 and variation 3 with 6.10 respectively.

iii.j. Organoleptic evaluation of RTE adai incorporated with tray dried cucumber peel

Table XVIII and Figure 13 revealed the organoleptic evaluation of RTE adai prepared with tray dried cucumber peel.

TABLE XVIII

Organoleptic evaluation of adai prepared from RTE millet mix incorporated with tray dried cucumber peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	8.0 ± 0.46	8.15 ± 0.59	8.15 ± 0.93	6.70 ± 0.92
Color	8.15 ± 0.67	8.35 ± 0.59	7.90 ± 0.83	6.80 ± 0.62
Taste	8.15 ± 0.81	8.35 ± 0.75	8.10 ± 0.66	6.70 ± 0.57
Flavor	8.20 ± 0.70	7.70 ± 0.80	8.00 ± 0.64	6.60 ± 0.60
Texture	8.10 ± 0.72	7.90 ± 0.85	8.05 ± 0.54	6.95 ± 0.76
Over all acceptability	8.05 ± 0.60	8.25 ± 0.64	8.15 ± 0.93	6.80 ± 0.70

Adai prepared from standard mix and with tray dried cucumber peel incorporated variations 1, 2 and 3 showed that in terms of appearance, variation 1 and 2 incorporated with 5 per cent and 10 per cent dehydrated cucumber peel respectively scored best with a mean score of 8.15 each. Color is one attribute essential for acceptability. In terms of color variation 1 and standard had a maximum score of 8.35 and 8.15 respectively. The scores obtained for flavor in adai ranged from 6.60 to 8.20, the maximum mean value is obtained from standard with 8.20 followed by variation 2 with 8, variation 1 with 7.70 and variation 3 with 6.60 respectively. Taste is an important attribute for sensory evaluation, taste contribute scores from 6.70 to 8.15 and maximum being in variation 1 with 8.35. This was followed by standard, variation 2 and variation 3. With regard to flavor and texture standard showed best result with mean score of 8.20 and 8.10 respectively. In terms of scores obtained for overall acceptability, variation 1 obtained 8.25 followed by variation 2 with 8.15, standard with 8.05 and variation 3 with 6.80.

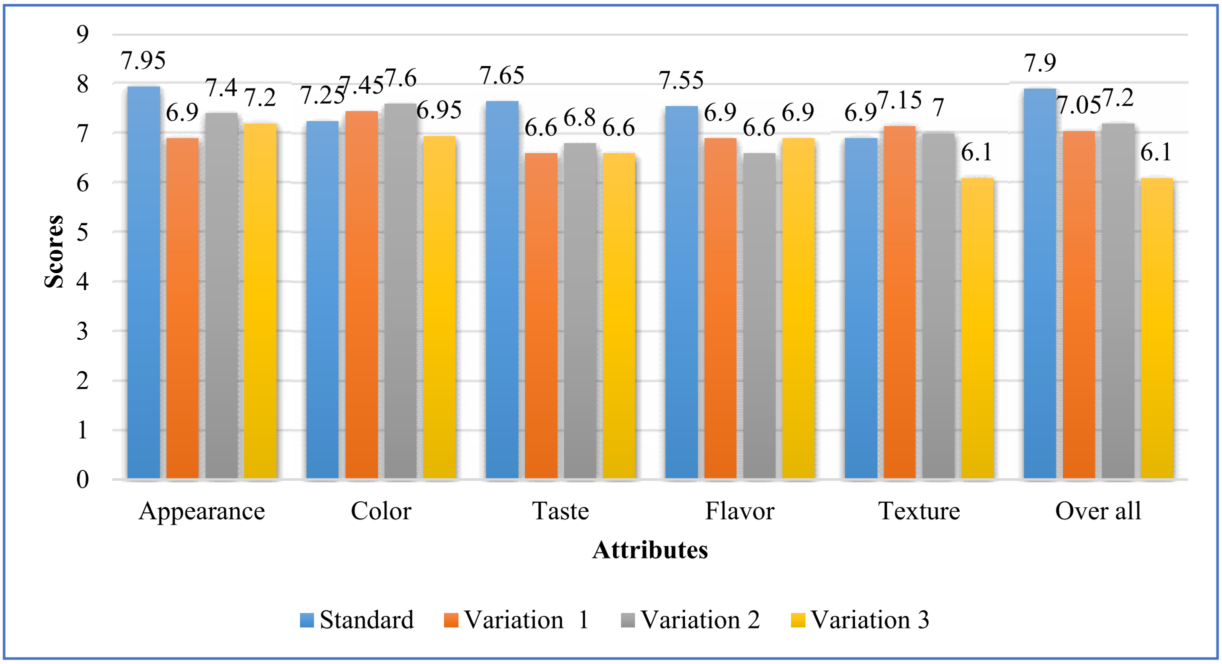


Figure 12

RTE millet chappati incorporated with tray dried potato peel

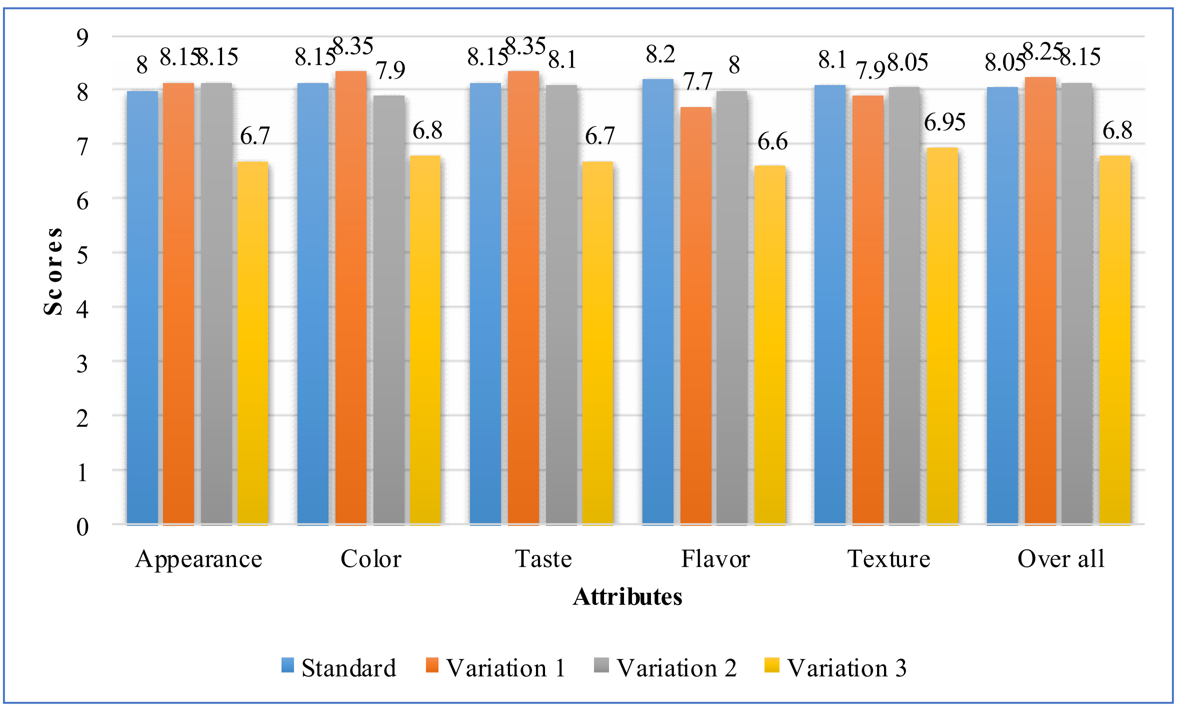


Figure 13

RTE millet adai incorporated with tray dried potato peel

iii.k. Organoleptic evaluation of RTE vegetable pulav incorporated with tray dried cucumber peel

Table XIX and Figure 14 gives the organoleptic evaluation of millet vegetable pulav prepared with tray dried cucumber peel.

TABLE XIX

Organoleptic evaluation of vegetable pulav prepared from RTE millet mix incorporated with dehydrated cucumber peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	8.35 ± 0.49	8.45 ± 0.60	6.75 ± 0.55	6.55 ± 0.51
Color	8.45 ± 0.51	8.50 ± 0.51	6.90 ± 0.79	6.60 ± 0.50
Taste	8.40 ± 0.50	8.45 ± 0.60	6.90 ± 0.64	6.55 ± 0.60
Flavor	8.65 ± 0.49	8.45 ± 0.51	7.15 ± 0.88	6.05 ± 0.69
Texture	8.35 ± 0.67	8.20 ± 0.70	6.60 ± 0.50	6.40 ± 0.60
Over all acceptability	8.43 ± 0.50	8.35 ± 0.75	7.15 ± 0.67	5.90 ± 0.97

The sensory scores of vegetable pulav prepared with tray dried cucumber peel showed in terms of appearance ranged from 6.55 to 8.45. The maximum mean value obtained from variation 1 with 8.45 followed by 8.35 for standard, 6.75 for variation 2 and 6.55 for variation 3. The color of variation 1 was highest with 8.50 whereas it was 8.45 for standard. This was followed by 6.90 for variation 2 and 6.60 for variation 3. The mean scores of taste was 8.40, 8.45, 6.90 and 6.55 for standard, variation 1, variation 2 and variation 3 respectively. In terms of flavor it was observed that the minimum mean value obtained 6.05 for variation 3 with 15 per cent incorporation. This was followed by 7.15 for variation 2, 8.45 for variation 1 and 8.65 for standard. Texture of standard, variation 1, variation 2 and variation 3 was 8.35, 8.20, 6.60 and 6.40 respectively. The mean overall acceptability score was 8.43 for standard; 8.35 for variation 1; 7.15 for variation 2 and 5.90 for variation 3 respectively.

iii.l. Organoleptic evaluation of RTE chappati incorporated with tray dried cucumber peel

Table XX and Figure 15 represent the organoleptic evaluation of RTE chappati prepared with tray dried cucumber peel.

TABLE XX

Organoleptic evaluation of chappati prepared from RTE millet mix incorporated with dehydrated cucumber peel

Criteria	Standard	Variation 1	Variation 2	Variation 3
Appearance	7.75 ± 0.64	7.30 ± 0.86	6.75 ± 0.64	7.20 ± 0.41
Color	7.85 ± 0.81	6.95 ± 0.83	7.40 ± 0.60	6.70 ± 0.80
Taste	8.05 ± 0.51	7.20 ± 0.77	6.80 ± 0.70	6.40 ± 1.10
Flavor	7.70 ± 0.86	7.25 ± 0.77	7.15 ± 0.88	6.80 ± 1.11
Texture	7.30 ± 0.86	7.25 ± 0.44	6.90 ± 0.97	6.60 ± 0.68
Over all acceptability	7.45 ± 0.76	6.90 ± 0.85	7.00 ± 0.92	6.55 ± 0.94

Table XX showed the result of sensory evaluation of chappati prepared with dehydrated cucumber peel. The sensory scores of the dehydrated cucumber peel incorporated chappati showed an appearance, color, taste, flavor, texture and overall acceptability. In terms of appearance, standard scored best with a mean score of 7.75 followed by variation 1 with 7.30, variation 3 with 7.20 and variation 2 with 6.75. In terms of color, variation 3 had minimum scores of 6.70 followed by variation 1 with 6.95, variation 2 with 7.40 and standard with 7.85. The scores obtained for flavor in chappati ranged from 6.80 to 7.70, the maximum obtained by standard with 7.70. Taste is an important attribute. Taste contribute scores from 6.40 to 8.05 and maximum being in standard with 8.05 followed by variation 1 with 7.20, variation 2 with 6.80 and variation 3 with 6.40. Regarding texture, mean scores of standard showed a value of 7.30, variation 1 with 7.25, variation 2 with 6.90 and variation 3 with 6.60 respectively. In terms of overall acceptability, standard obtained 7.45 followed by variation 2 with 7.00 mean scores. Variation 1 with 6.90 scores and variation 3 with 6.55 respectively.

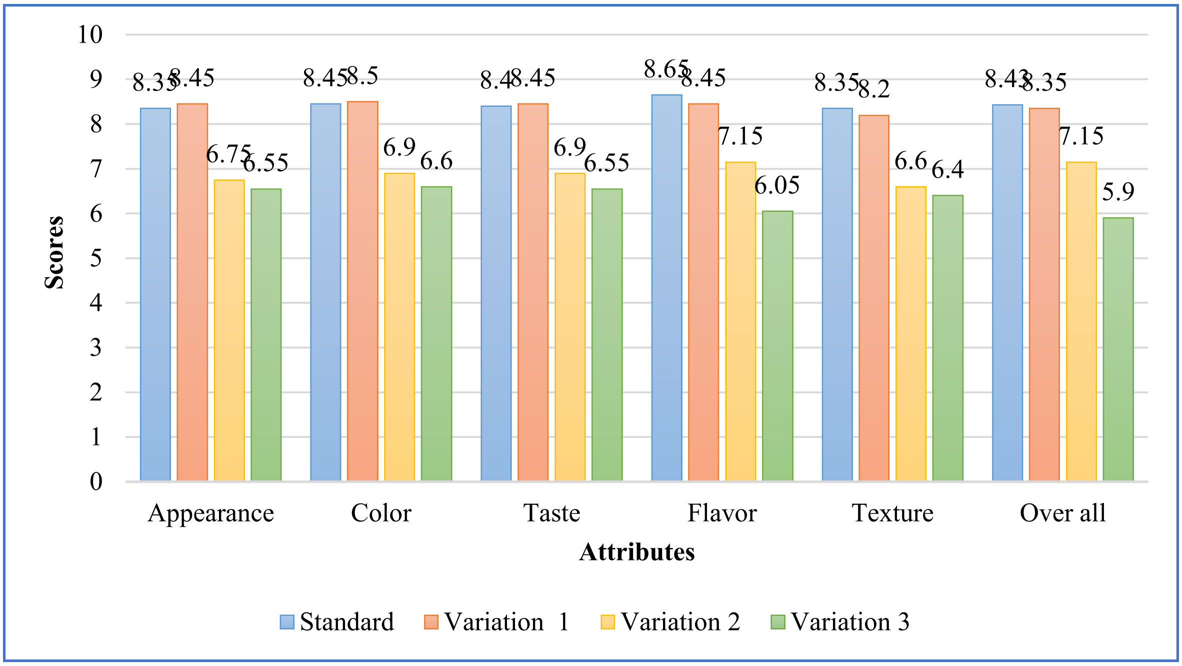


Figure 14

RTE millet vegetable pulav with tray dried cucumber peel

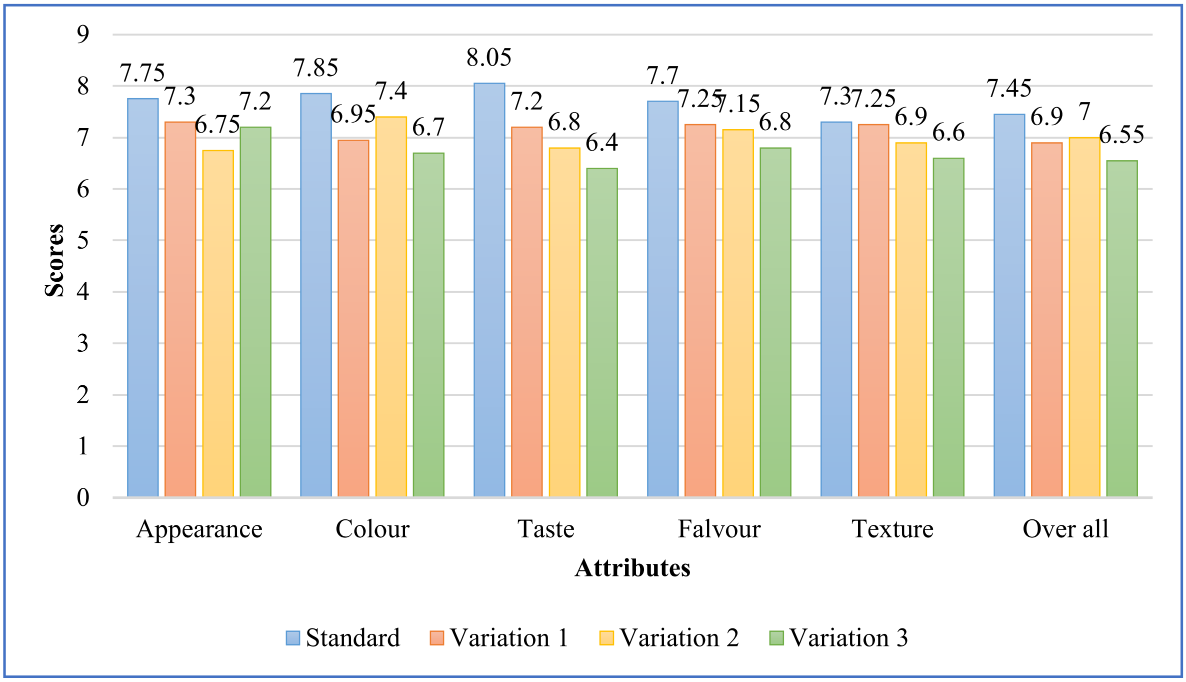


Figure 15

RTE millet chappati with tray dried cucumber peel

iii.m. Overall acceptability of RTE millet mix incorporated with tray dried samples

Table XXI and reveals the overall acceptability of RTE millet mix incorporated with tray dried fruit and vegetable peels.

TABLE XXI

Overall acceptability of RTE millet mix incorporated with tray dried fruit and vegetable peels.

Tray dried peel	Recipe	Standard	Variation 1	Variation 2	Variation 3
Banana	Adai	8.50 ± 0.61	8.20± 0.62	7.40 ± 0.88	6.80 ± 0.89
	Vegetable pulav	8.05 ± 0.60	8.25 ± 0.64	8.15 ± 0.93	6.80 ± 0.70
	Chappati	7.70 ± 0.80	7.15 ± 0.84	6.75 ± 0.85	6.40 ± 0.88
Grapes	Adai	8.40 ± 0.50	8.45 ± 0.51	7.10 ± 0.72	6.55 ± 0.51
	Vegetable pulav	8.45 ± 0.51	8.45 ± 0.63	6.65 ± 0.49	6.50 ± 0.51
	Chappati	7.40 ± 0.60	5.75 ± 0.91	5.50 ± 0.54	5.65 ± 0.63
Potato	Adai	8.50 ± 0.61	8.20 ± 0.62	7.40 ± 0.88	6.80 ± 0.89
	Vegetable pulav	7.65 ± 0.81	7.00 ± 0.26	6.70 ± 0.92	6.40 ± 0.88
	Chappati	7.90 ± 0.85	7.05 ± 0.94	7.20 ± 0.89	6.10 ± 0.71
Cucumber	Adai	8.05 ± 0.60	8.25 ± 0.64	8.15 ± 0.93	6.80 ± 0.70
	Vegetable pulav	8.43 ± 0.50	8.35 ± 0.75	7.15 ± 0.67	5.90 ± 0.97
	Chappati	7.45 ± 0.76	6.90 ± 0.85	7.00 ± 0.92	6.55 ± 0.94

The overall acceptability of RTE millet recipes incorporated with tray dried fruit and vegetable showed that, for banana peel incorporated adai mix, standard scored maximum value with 8.50 followed by variation 1 with 8.20, variation 2 with 7.40 and variation 3 with 6.80. For vegetable pulav, it was observed that variation 1 scored a maximum value of 8.25 followed by variation 2 with 8.15, standard with 8.05 and variation 3 with 6.80. For chappati the maximum overall acceptability secured for standard with mean value of 7.70, variation 1 with 7.15, variation 2 with 6.75 and variation 3 with 6.40.

The overall acceptability of grapes peel incorporated adai showed that variation 3 got minimum mean value of 6.55 followed by variation 2-7.10, standard-8.40 and variation 1-8.45. Acceptability of vegetable pulav prepared from grapes peel, standard and variation 1 scored maximum value of 8.45 followed by variation 2-6.65 and variation 3-6.50. In terms of chappati prepared from grapes peel, standard showed highest mean value of 7.40 followed by 5.75, 5.50 and 5.65 for variation 1, 2 and 3 respectively.

The overall acceptability of adai prepared from tray dried potato peel showed a score of that 8.50 for standard with maximum score followed by variation 1 with 8.20, variation 2 with 7.40 and variation 3 with 6.80. For vegetable pulav, prepared from tray dried potato peel, standard got maximum mean value of 7.65, variation 1 got 7.00, variation 2 got 6.70 and variation 3 got 6.40. The mean value obtained for overall acceptability of chappati prepared from tray dried potato peel, had a score maximum of 7.90 for standard followed by variation 1 with 7.05, variation 2 with 7.20 and variation 3 with 6.10 respectively.

The overall acceptability obtained for adai prepared from cucumber peel, variation 1 got mean value of 8.25, variation 2 got 8.15, standard got 8.05 and variation 3 got 6.80 respectively. The overall acceptability of vegetable pulav secured 8.43 for standard, 8.35 for variation 1, 7.15 for variation 2 and 5.90 for variation 3. Regarding the overall acceptability of chappati prepared from tray dried cucumber peel, standard obtained 7.45 followed by variation 2 with 7.00, variation 1 with 6.90 and variation 3 with 6.55 respectively.

The overall results indicates that variation – 1 with 5 per cent incorporated tray dried vegetable/fruit peel powder had an overall acceptability when compared with variation 2 and 3. Hence this level of incorporation can be included in the daily dietaries. This may enhance the nutraceutical potential of the food consumed.

iv. Cost analysis of the developed RTE millet recipes

Food cost is the ideal percentage which indicates the actual percentage of food.

Table XXII reveals the cost of RTE adai millet mix for various recipes incorporated with tray dried fruit and vegetable peel.

TABLE XXII

Cost analysis of RTE millet mix

Fruit/vegetable	RTE millet mix	Cost (Rs./1000g)
Banana	Adai	99.20
	Vegetable pulav	82.20
	Chappati	69.70
Grapes	Adai	99.40
	Vegetable pulav	82.40
	Chappati	69.90
Potato	Adai	99.10
	Vegetable pulav	82.10
	Chappati	69.50
Cucumber	Adai	99.25
	Vegetable pulav	82.25
	Chappati	69.50

Indian consumers are highly price sensitive. Cost of RTE adai incorporated with tray dried banana peel was Rs. 99.20, tray dried grapes peel was Rs. 99.40, potato peel was Rs. 99.10 and with cucumber peel was Rs 99.25.

The cost of vegetable pulav incorporated with banana peel was Rs. 82.20, for grapes peel Rs.82.40, for potato peel incorporated vegetable pulav cost was Rs.82 and for cucumber peel cost was Rs.82.25.

The cost of chappati mix prepared from tray dried cucumber peel was Rs. 69.50, for potato peel incorporated chappati cost was Rs 69.50, for grapes peel incorporated chappati mix cost was Rs. 69.90 and banana peel incorporated chappati mix was Rs. 69.70.

V. SUMMARY AND CONCLUSION

Fruits and vegetables are important components of a healthy diet. Reduced fruit and vegetable consumption is linked to poor health and increased risk of Non Communicable Diseases (NCDs).Fruits and vegetables are rich sources of vitamins and minerals, dietary fibre and a host of beneficial non-nutrient substances including plant sterols, flavonoids and other antioxidants. Consuming a variety of fruits and vegetables helps to ensure an adequate intake of many of these essential nutrients. The millets have high fiber content, their protein quality and mineral composition contribute significantly to nutritional security, in the millet growing areas. Millets are highly nutritious, non-glutinous and non-acid forming foods, soothing and easy to digest. They are least allergenic and most digestible grains available. Millets are also rich source of phytochemicals and micronutrients. Millets also contain B vitamins especially niacin, B6 and folic acid, calcium, iron, potassium, magnesium and zinc.

The present study entitled "**Development of RTE Millet Mixes with fruit and vegetable peel"** was aimed at evaluation of millet based RTE mixes recipes incorporated with dehydrated fruit and vegetable peel. The fruit and vegetable peel included banana, grapes, potato and cucumber and was dehydrated using different dehydration methods namely tray drying, microwave drying and sun drying. Nutrient analysis of fresh and dehydrated fruit and vegetable peel was carried out. Formulation of RTE millet mixes namely adai mix, vegetable pulav mix and chappati mix was prepared. As tray dried sample had maximum retention of nutrients, tray dried peel was incorporated into RTE mixes. The level of incorporation of tray dried fruit and vegetable peels was at 5, 10 and 15 per cent with variation 1, 2 and 3 respectively. The developed recipes were subjected to organoleptic evaluation by 20 semi- trained panel members. The study protocol was approved by the institutional Ethical Committee of Avinashilingam University and the approval number was AUW/IHEC/FSN-15-16/XMT-06. The organoleptic scores of the recipes were statistically analyzed for mean and standard deviation to find the best acceptable recipe.

The salient findings of the study are summarized below:

- Five hundred grams of the fresh fruit and vegetable peels were taken each for dehydration. Weight of the banana peel from 500g of fruit was 146 g; grapes peel was 214 g; potato was 100 g and cucumber was 75 g.
- Tray drying took 20 hours for dehydrating banana peel and grapes peel. From 146 g of the fresh banana peel, 10 g of dehydrated peel and from 214 g of fresh grapes peel 14.5 g of dehydrated was obtained. Potato and cucumber dehydrated in 15 hours, dehydrated weight of the potato peel was 9 g and for cucumber peel 8g from 100 and 75 g of fresh peel respectively. It was seen that microwave drying took least time to dehydrate when the temperature was maintained at 40˚C for all selected fruit and vegetable peels. Banana peel dehydrated in 46 minutes; grapes peel in 26 minutes and potato and cucumber each dehydrated in 24 minutes and the final moisture content in the microwave dried sample was seen to be below 10 per cent. Weight of the dehydrated peels was weighed and obtained. 20g of banana peel; 16g for grapes peel; 18g of for potato peel and 9g of cucumber peel was obtained after dehydration. The drying time taken for sun drying of each sample was longest. Banana and grapes peel dehydrated in 28 hours because of the high moisture content and dehydration of potato and cucumber peels in 20 hours. Dehydrated weight of the banana peel was 15.6g; grapes peel was 16.1 g; whereas potato peel was 23.5 g and for cucumber peel 15g. From the dehydration methods adopted, it can be observed that the weight of the dehydrated peel was least in cucumber peel with 8, 9 and 15g for tray, microwave and sun drying respectively from 75g of the peel. It means that more moisture content is seen in cucumber peel compared with grapes, banana and potato.
- The carbohydrate content of fresh banana peel was 24g, tray dried 20g, microwave dried 18.3g and sun dried 15g respectively. The protein content of fresh banana peel was 3.5 g, for tray drying 3.15g, for microwave drying and sun drying the protein content was 2.9 g and 2g respectively. The fat content was 1.65g for fresh peel; 1.53 g for tray dried peel; 1.2 g for microwave dried peel and one gram for sun dried peel. Fiber present in fresh peel was 3.03 g; tray dried peel was 2.9 g; microwave dried peel was 2.1 g and sun dried banana peel was 1.9g. Vitamins and minerals which were analyzed include calcium, iron, vitamin C and vitamin A. Calcium content in fresh peel was 19.00 mg whereas tray dried

peel had 17mg of calcium. Fourteen mg of calcium was present in microwave dried peel and 11mg in sun dried peel. The iron content of fresh and tray dried banana peel was 1.1 mg; one mg and 0.3 mg was present in microwave dried and sun dried banana peel. Vitamin C present in fresh peel was 10.1 mg followed by 9 mg in tray dried peel; 7.5 mg in microwave dried peel and 5mg in sun dried banana peel. 50µg of vitamin A was present in fresh peel whereas tray, microwave and sun dried banana peel had 47.3 µg, 43µg and 39µg respectively. It was observed that tray dried banana peels had maximum retention of nutrients compared to other dehydration methods.

- The carbohydrate, protein, fat and fiber content of fresh grapes peel found to be 17g, 0.63g, 0.15g and 0.70g respectively. The minerals such as calcium and iron present in fresh peel was 10mg and 0.30mg. Vitamin C and A was found to be 9 mg and 35µg in fresh grapes peel. Tray dried grapes peel contain 15.60g of carbohydrate; 0.50g of protein; 0.12g of fat; 0.60g fiber; 8mg of calcium; 0.26mg of iron; 7mg of vitamin C and 33µg of vitamin A. The microwave dried grapes peel had 11.70g of carbohydrate; 0.27g of protein; 0.07g of fat; 0.45g of fiber; 5.00mg of calcium; 0.22mg of iron; 5.10mg of vitamin C and 27µg of vitamin A. Sun dried grapes peel had 9.3g of carbohydrate; 0.1g of protein; 0.04g of fat; 0.1 g of fiber; 4mg of calcium; 0.15mg of iron; 3mg of vitamin C and 23µg of vitamin A. Tray dried grapes peel had maximum retention of nutrients which was closest to that of the fresh grapes peel revealing that tray dried grapes peel retained more nutrients.
- The fresh potato peel had 33.70g of carbohydrate; 3.50g of protein; 3.50g of fat; 4.00g of fiber; 19mg of calcium; one mg of iron; 19.00mg of vitamin C and 32.00µg of vitamin A. The tray dried potato peel had 32.7g of carbohydrate; 2.90g of protein; 3.10g of fat; 3.60g of fiber; 15.30mg of calcium; one mg of iron; 17.00mg of vitamin C and 29µg of vitamin A. Compared to fresh peel, the microwave dried potato peel had 28.00g of carbohydrate; 2.2g of protein; 2.90g each of fat and fiber; 10.00mg of calcium; 0.80mg of iron; 12mg of vitamin C and 22µg of vitamin A. When compared to fresh and other two types of dehydration techniques, sun dried grapes peel had low nutritive value with carbohydrate 23.5g; protein 1.9g; fat 2g; fiber 2.10g; calcium 8mg; iron 0.40mg; vitamin C 10mg and vitamin A 18µg. Dehydrated potato peel revealed that the maximum nutrient retention was tray dried samples and minimum was sun dried samples.

- Carbohydrate content of fresh cucumber peel was 3.5g followed by protein 0.60g; fat 0.11g; fiber 0.45g; calcium 16mg; iron 0.20mg; vitamin C 2.50mg and vitamin A 52.00µg. When compared to fresh peel the nutritive value of the tray dried cucumber peel was decreased. It was carbohydrate 2.90g; protein 0.49g; fat 0.90g; fiber 0.30g; calcium 15mg; iron 0.19mg; vitamin C 2.10mg and vitamin A 49.5µg. Microwave dried cucumber peel had 2.30g of carbohydrate; 0.30g of protein; 0.40g of fat; 0.25g of fiber; 12mg of calcium; 0.12mg of iron; 1.9mg of vitamin C and 43µg of vitamin A. Sun dried cucumber peel had low amount of nutrients compared to fresh and other two dehydration methods. Carbohydrate, protein, fat and fiber was found to be 1.90g, 0.29g, 0.2g and 0.2g respectively along with calcium, iron, vitamin C, vitamin A with 9mg, 0.1mg, 1mg and 40µg respectively. From the values obtained, it is clear that tray dried cucumber peel had maximum retention of nutrients followed by microwave and sun dried samples. Also the nutrient content of tray dried samples was comparable with the fresh cucumber peels.
- It was seen that potato had high amount i.e.39 mg of phytic acid per 100g of dehydrated peels. This was followed by grapes peel with 18 mg; banana peel with 12 mg and cucumber peel with 10 mg. Phytic acid content was higher in tray dried potato peel and least in tray dried cucumber peel. The safe upper limit of phytic acid was found to be 24 mg, 23 mg, 37 mg and 20 mg for banana, grapes, potato and cucumber respectively. The values obtained in the present study are safe within the upper limits and hence can be incorporated in the RTE mix.
- Organoleptic evaluation of RTE millet adai incorporated with banana peel revealed that the appearance for standard, variation 1 and 2 was 8.1 and for variation 3, 7.4. The mean values obtained for color was 8.10 for standard, 8.25 for variation 1, 7.65 for variation 2 and 6.8 for variation 3. The taste of variation 3 was maximum with 8.5 followed by 8.45 for standard, 7.4 for variation 2 and 6.8 for variation 3. The flavor of variation 1 was highest with 8.6 whereas it was 8.4 for standard. This was followed by 7.5 for variation 2 and 6.9 for variation 3. The mean scores for texture was 8.1, 8.7, 7.3 and 6.95 for standard, variation 1, variation 2 and variation 3 respectively.The overall acceptability of the RTE millet adai mix revealed that variation 1 had a maximum score of 8.2 and was comparable with the standard of 8.5.

- Vegetable pulav incorporated with tray dried banana peel powder. Prepared from standard and variations 1, 2 and 3 showed that in terms of appearance, scores a mean value of 8.15 for variation 1 and 2, 8 for standard and 6.70 for variation 3. In terms of color, standard and three variations got scores between 6.80 to 8.35.Variation 1 scored maximum mean value of 8.35 followed by standard - 8.15, variation 2 -7.90 and variation 3 – 6.80. Taste contributed scores from 6.70 to 8.35. The maximum mean value is obtained for variation 1 with mean value of 8.35, standard with 8.15, variation 2 with 8.10 and variation 3 with 6.70. The scores obtained for flavor in vegetable pulav with dehydrated banana peel ranged from 6.60 to 8.20, the maximum score obtained for standard with mean value of 8.20 followed by variation 2 with 8, variation 1 with 7.70 and variation 3 with 6.60. With regard to texture standard showed the best result with mean value of 8.10 followed by mean scores of 8.05, 7.9 and 6.95 for variation 2, variation 1 and standard respectively. In terms of scores obtained for overall acceptability standard obtained 8.05 scores followed by variation 1 with 8.25, variation 2 with 8.15 and variation 3 with 6.80.
- The appearance of chappati prepared with tray dried banana peel powder was 7.75 for standard, 7.45 for variation 1, 6.80 for variation 2 and 6.65 for variation 3. The mean value of color for standard was 7.90, variation 1 and variation 2 was 6.70 and variation 3 was 6.50. The values obtained for taste was maximum in standard with 7.65 followed by variation 3 with 6.45, variation 2 with 6.10 and variation 1 with 5.90. The scores for flavor ranged between 7.75 to 6.20. The maximum mean value was obtained for standard with a mean value of 7.75 followed by variation 1 with 6.95, variation 2 with 6.65 and variation 3 with 6.20. The mean values were 7.75, 7.25, 6.40 and 6.10 for standard, variation 1, variation 2 and variation 3 for texture. In terms of overall acceptability, standard scored 7.70, variation 1 scored 7.15, variation 2 scored 6.75 and variation 3 scored 6.40 respectively.
- It is evident that the mean appearance score value for appearance of standard was 8.35, variation 1 was 8.34, variation 2 was 6.75 and variation 3 was 6.55 for adai incorporated with tray dried grapes peel. The score for color ranged from 6.65 to 8.50. The maximum score obtained for variation 1 was 8.50 followed by standard with 8.45, variation 2 with 6.90 and variation 3 with 6.65. The mean scores for the taste of standard was 8.40,

variation 1 was 8.45, variation 2 was 6.90 and variation 3 was 6.60. The flavor of the standard observed a mean score of 8.65, variation 1 with 8.42, variation 2 with 7.20 and variation 3 with 6.10. With regard to texture, standard, variation 1, variation 2 and variation 3 got mean scores of 8.35, 8.30, 6.60 and 6.50 respectively. The scores obtained for over all acceptability of variation 1 with incorporation of 10 per cent got mean value of 8.45 followed by standard with 8.40, variation 2 with 7.10 and variation 3 with 6.55 respectively.

- The standard vegetable pulav prepared from tray dried grape peel and variations 1, 2 and 3 showed that in terms of appearance, variation 1- 5 per cent incorporation scored best result with mean value of 8.60. Variation 3 scored least value of 6.60 and standard and variation 2 score mean values of 8.15 and 7.05 respectively. In terms of color, the minimum score obtained was variation 2 with mean value of 6.50 followed by variation 3 with 6.55, standard with 8.40 and variation 2 with 8.55 respectively. The mean values for taste of standard was 8.35, variation 1 was 8.30, variation 2 was 6.90 and variation 3 with 7.20. The scores for flavor was 8.30 for standard, 8.50 for variation 1, 7.15 for variation 2 and 6.70 for variation 3 correspondingly. Texture obtained a mean value of 8.25 for standard, 8.17 for variation 1, 6.70 for variation 2 and 7.20 for variation 3. The overall acceptability for standard and variation 1 was 8.45, variation 2 was 6.65 and variation 3 was 6.50 respectively.
- It is clear that the appearance of standard was maximum with mean value of 7.85 followed by variation 1 and 2 with 6.20 and variation 3 with 5.95 for chappati incorporated with tray dried grapes peel powder. Color contributes scores from 7.20 to 6.30. In terms of taste and flavor standard got mean value of 6.80 and 7.35 respectively, variation 1 got 6.70 and 6.65 respectively variation 2 got 5.20 and 5.05 respectively and variation 3 got 5.30 and 6.10 respectively. Texture of standard, variation 1, variation 2 and variation 3 secured a mean values of 7.20, 5.60, 5.56 and 5.60 correspondingly. Over all acceptability of standard was 7.40, variation 1 was 5.75, variation 2 was 5.50 and variation was 5.65.
- Adai prepared from standard and variations 1, 2 and 3 incorporated with tray dried potato peel showed that in terms of appearance, variation 1 and 2 have no significant difference. Standard and variation 3 had a decreased value of 8.2 and 7.4 respectively. In terms of

color, standard and three variations got scores between 6.80 to 8.10. Standard had maximum score of 8.10. Taste as an important attribute contribute scores from 6.80 to 8.45. The maximum mean value obtained was for variation 1 with 8.5. The scores obtained for flavor in adai ranged from 6.90 to 8.60, the maximum obtained for variation 1 with 8.60. With regard to texture standard showed the best score with mean value of 8.10. In terms of scores obtained for overall acceptability standard obtained scores 8.50 followed by variation 1 with 8.20, variation 2 with 7.40 and variation 3 with 6.80.

- The appearance of vegetable pulav prepared from tray dried potato peel standard and variations 1, 2 and 3. Standard scored best result with mean value of 8.20. Variation 3 scored a decreased score of 6.65. In terms of color, standard and three variations got scores between 6.55 to 7.80.Variation 1 and 2 had mean value of 6.70 each. The maximum mean score for color was for standard with 7.8. The maximum mean value obtained for taste - standard was 7.60 followed by variation 3 with 6.55, variation 2 with 6.10 and variation 1 with 5.95. The scores obtained for flavor, ranged from 6.05 to 7.65, the minimum score 6.05 for variation 1, 6.30 for variation 3, 6.65 for variation 2 and 7.65 for standard. With regard to texture, standard showed the best result with mean value of 7.70 followed by variation 1 with 7.35, variation 2 with 6.50 and variation 3 with 6.10 respectively. Overall acceptability of standard obtained 7.65 followed by variation 1 with 7.00, variation 2 with 6.70 and variation 3 with 6.40.
- Regarding to the appearance of chappati prepared with tray dried potato peel, the score was 7.95 for standard; 6.90 for variation 1; 7.40 for variation 2 and 7.20 for variation 3. Color contributes scores from 6.95 to 7.45. The maximum mean value was 7.60 obtained for variation 2 followed by 7.45 for variation 1, 7.25 for standard and 6.95 for variation 3. The minimum mean value obtained was 6.60 for variation 1 and 3, 6.80 for variation 2 and 7.65 for standard for taste respectively. In terms flavor variation 2 got 6.60 the least, variation 1 and 3 got 6.90, standard got 7.55 respectively. Texture ranged from 6.10 to 7.15. Variation 1 with 5 per cent incorporation got maximum mean value of 7.15 followed by variation 2 with 7, standard with 6.90 and variation 3 with 6.10. The mean values obtained for overall acceptability of standard was 7.90, variation 1 with 7.05, variation 2 with 7.20 and variation 3 with 6.10 respectively.

- Adai prepared from standard mix and with tray dried cucumber peel incorporated variations 1, 2 and 3 showed that in terms of appearance, variation 1 and 2 incorporated with 5 per cent and 10 per cent dehydrated cucumber peel respectively scored best with a mean score of 8.15 each. In terms of color variation 1 and standard had a maximum score of 8.35 and 8.15 respectively. The scores obtained for flavor in adai ranged from 6.60 to 8.20, the maximum mean value is obtained from standard with 8.20 followed by variation 2 with 8, variation 1 with 7.70 and variation 3 with 6.60 respectively. Taste contribute scores from 6.70 to 8.15 and maximum being in variation 1 with 8.35. This was followed by standard, variation 2 and variation 3. With regard to flavor and texture standard showed best result with mean score of 8.20 and 8.10 respectively. In terms of scores obtained for overall acceptability, variation 1 obtained 8.25 followed by variation 2 with 8.15, standard with 8.05 and variation 3 with 6.80.
- The maximum mean value obtained for vegetable pulav - variation 1 with 8.45 followed by 8.35 for standard, 6.75 for variation 2 and 6.55 for variation 3. The color of variation 1 was highest with 8.50 whereas it was 8.45 for standard. This was followed by 6.90 for variation 2 and 6.60 for variation 3. The mean scores of taste was 8.40, 8.45, 6.90 and 6.55 for standard, variation 1, variation 2 and variation 3 respectively. In terms of flavor it was observed that the minimum mean value obtained 6.05 for variation 3 with 15 per cent incorporation. This was followed by 7.15 for variation 2, 8.45 for variation 1 and 8.65 for standard. Texture of standard, variation 1, variation 2 and variation 3 was 8.35, 8.20, 6.60 and 6.40 respectively. The overall mean acceptability score was 8.43 for standard; 8.35 for variation 1; 7.15 for variation 2 and 5.90 for variation 3 respectively.
- The sensory scores of the dehydrated cucumber peel incorporated chappati showed an appearance, color, taste, flavor, texture and overall acceptability. In terms of appearance, standard scored best with a mean score of 7.75 followed by variation 1 with 7.30, variation 3 with 7.20 and variation 2 with 6.75. In terms of color, variation 3 had minimum scores of 6.70 followed by variation 1 with 6.95, variation 2 with 7.40 and standard with 7.85. The scores obtained for flavor in chappati ranged from 6.80 to 7.70, the maximum obtained by standard with 7.70. Taste is an important attribute. Taste contribute scores from 6.40 to 8.05 and maximum being in standard with 8.05 followed by variation 1 with 7.20, variation 2 with 6.80 and variation 3 with 6.40. Regarding

texture, mean scores of standard showed a value of 7.30, variation 1 with 7.25, variation 2 with 6.90 and variation 3 with 6.60 respectively. In terms of overall acceptability, standard obtained 7.45 followed by variation 2 with 7.00 mean scores. Variation 1 with 6.90 scores and variation 3 with 6.55 respectively.

- The overall acceptability of RTE millet recipes incorporated with tray dried fruit and vegetable showed that, for banana peel incorporated adai mix, standard scored maximum value with 8.50 followed by variation 1 with 8.20, variation 2 with 7.40 and variation 3 with 6.80. For vegetable pulav, it was observed that variation 1 scored a maximum value of 8.25 followed by variation 2 with 8.15, standard with 8.05 and variation 3 with 6.80. For chappati the maximum overall acceptability secured for standard with mean value of 7.70, variation 1 with 7.15, variation 2 with 6.75 and variation 3 with 6.40.
- The overall acceptability of grapes peel incorporated adai showed that variation 3 got minimum mean value of 6.55 followed by variation 2-7.10, standard-8.40 and variation 1-8.45. Acceptability of vegetable pulav prepared from grapes peel, standard and variation 1 scored maximum value of 8.45 followed by variation 2-6.65 and variation 3-6.50. In terms of chappati prepared from grapes peel, standard showed highest mean value of 7.40 followed by 5.75, 5.50 and 5.65 for variation 1, 2 and 3 respectively.
- The overall acceptability of adai prepared from tray dried potato peel showed a score of that 8.50 for standard with maximum score followed by variation 1 with 8.20, variation 2 with 7.40 and variation 3 with 6.80. For vegetable pulav, prepared from tray dried potato peel, standard got maximum mean value of 7.65, variation 1 got 7.00, variation 2 got 6.70 and variation 3 got 6.40. The mean value obtained for overall acceptability of chappati prepared from tray dried potato peel, had a score maximum of 7.90 for standard followed by variation 1 with 7.05, variation 2 with 7.20 and variation 3 with 6.10 respectively.
- The overall acceptability obtained for adai prepared from cucumber peel, variation 1 got mean value of 8.25, variation 2 got 8.15, standard got 8.05 and variation 3 got 6.80 respectively. The overall acceptability of vegetable pulav secured 8.43 for standard, 8.35 for variation 1, 7.15 for variation 2 and 5.90 for variation 3. Regarding the overall acceptability of chappati prepared from tray dried cucumber peel, standard obtained 7.45 followed by variation 2 with 7.00, variation 1 with 6.90 and variation 3 with 6.55 respectively.

- ➢ The overall results indicates that variation – 1 with 5 per cent incorporated tray dried vegetable/fruit peel powder had an overall acceptability when compared with variation 2 and 3. Hence this level of incorporation can be included in the daily dietaries. This may enhance the nutraceutical potential of the food consumed.
- ➢ Cost of RTE adai incorporated with tray dried banana peel was Rs. 99.2, grapes peel was Rs. 99.4, potato peel was Rs. 99.1 and with cucumber peel was Rs 99.25.The cost of vegetable pulav incorporated with banana peel was Rs. 82.2, for grapes peel Rs.2.4, for potato peel incorporated vegetable pulav cost was Rs.82 and for cucumber peel cost was Rs.82.25. The cost of chappati mix prepared from cucumber peel was Rs. 69.5, for potato peel cost was Rs 69.5, for grapes peel was Rs. 69.9 and banana peel was Rs. 69.7.

In conclusion, the study revealed that the RTE millet mixes incorporated with tray dried fruit and vegetable peels were well accepted at 5 per cent level of incorporation into the selected recipes. These RTE millet mixes/recipes can be prepared at home scale level by the working mothers, cooked and consumed whenever required. The millet – fruit/vegetable peel combo is nutrition rich, calorie dense and packed with anti-oxidants and phytochemicals. Hence can be consumed by all age groups. Intake of millet – fruit/vegetable peel combo must be widely promoted both for its content of fiber and other nutrients.

Recommendations for further research:

- ✓ Studies on standardization using other fruit and vegetable peels with other methods of dehydration.
- ✓ Studies on other anti-nutritional substances and pesticide residue present in fruit and vegetable peel.
- ✓ Studies using other millets of nutritional importance.
- ✓ Studies on assessment of bioactive components in selected fruit and vegetable peel.
- ✓ *In vitro* antioxidant assays of fruit and vegetable peel incorporated recipes.
- ✓ Toxicological studies in animal to prove its safety.
- ✓ Popularization of fruit and vegetable peel incorporated recipes among masses to enhance their micronutrient and antioxidant status.
- ✓ Shelf life studies of the developed RTE millet mixes must be carried out.

BIBLIOGRAPHY

- Abascal, K., Ganora, L. and Yameli, E. (2005). The effect of freeze-drying and its implications for botanical medicine: Areview. *Phytotherapy research*.19: 655-660
- Adebiyi, A., Ganesan, A.P., Prasad, R.N. (2003) Tocolytic and toxic activity of papaya seed extract on isolated rat uterus. Life Sci. 74:581–92.
- Adoki (2008). Factors affecting yeast growth and protein yield production from orange, plantain and banana wastes processing residues using Candida Spp. *African J. Biotech*. 7: 290-295.
- Ahnwange, B.A. (2008). Chemical Composition of Musa Sapientum (Banana) peels. *Journal Food Technology*. 6(6): 263-266
- Anderson, A.S., Wrieden, W., Tasker, S., and Gregor, A. (2008). Ready meals and nutrient. 67, E223 433
- Antony, U. and Chandra, T.S. (2006). Antinutrient reduction and enhancement in protein, starch and mineral availability in fermented flour of fingermillet (Eleusine coracana). *J. Agric. Food Chem.* 46: 2578-2582.
- AOAC (1996) Association of Official Analytical Chemists. Official methods of analysis, 16th edn. Gaithersburg.
- Arapoglou, D., Varzakas, T., Vlyssides, A. and Israilides, C. (2010). Ethanol production from potato peel waste (PPW). Waste Management, 30: 1898–1902.
- Aregheore, E.M. (1998). A note on the nutritive value of dry ripe plantain peels as a replacement of maize for goats. *Journal of Animal and Feed Science*, 7: 55−62.
- Awika, J.M., Rooney, L.W. and Waniska, R.D. (2004). Anthoycanins from black sorghum and their antioxidant properties. *Food Chem*., 90: 293-301.
- Azeredo, H.M. (2009). Betalains: properties, sources, applications, and stability − a review. *International Journal Food Science and Technology*, 44: 2365−2376.
- Babbar, N., Oberoi, H.S., Uppal, D.S. & Patil, R.T. (2011). Total phenolic content and antioxidant capacity of extracts obtained from six important fruit residues. *Food Research International*, 44: 391–396.
- Bakshi, M.P.S. & Wadhwa, M. (2012). Nutritional evaluation of baby corn husk − A new feed resource for livestock. *Indian Journal of Animal Sciences*, 82:1548−1550.
- Bazzano A., Lydia. (2002). Fruit and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *American Journal for Clinical Nutrition*. 76 (1): 93-99.
- Beecher, G.R., (2003). An overview of dietary flavonoids nomenclature, occurrence and intake. *J. Nutr*. 133(10): 324-325.
- Bharya., Devi PB., Vijayabharathi R. (2012). A Study on the Benefits of Convenience Foods to Working Women. *A Journal of Hospitality*. 1(1):57-60
- Bingham, S., Khaw, K. T. (2001). “Relation between plasma ascorbic acid and mortality in men and women in EPIC-Norfolk prospective study: a prospective population study.” The Lancet 357(9257): 657-663.

- Birchal, V.S., Passos, M.L., Wildhagen, G.R.S. and Mujumdar, A.S (2005). Effect of spray-dryer operating variables on the whole milk powder quality. Drying Technology, 23(3), 611-636.
- Brandt M.A., Skinner E.Z., and Coleman J.A. (2003). Texture profile method.
- J. Food Sci. 28, 404-409
- Busani, M., Patrick, J. M., Amold, H. and Voster, M. (2011). Nutritional characterization of Moringa leaves. *African Journal of Biotechnology*, 10(60): 12925-12933.
- Čanadanović-Brunet, J.M., Savatović, S.S., Ćetković, G.S., Vulić, J.J., Dj ilas, S.M., Markov, S.L. & Cvetković, D.D. (2011). Antioxidant and antimicrobial activities of beet root pomace extracts. *Czech Journal of Food Science*, 29: 575–585.
- Candel, M.J.J. M. (2001). Consumers'convenience orientation towards meal preparation: conceptualization and measurement. Appetite. 36(1):15-28.
- Chandel, G., KUMAR, R., MAHIMA,M., KUMAR, M.D. (2014). Nutritional properties of minor millets: neglected cereals with potential to combat malnutrition. Current science.107(7): 1109
- Chen, C.A.; Lindsay, D.; von Holya, A.(2011) Microbiological survey of ready-to-eat foods and associated preparation surfaces in retail delicatessens, Johannesburg, South Africa. *J. Food Control.* 19:727–733.
- Chieh, C. (2006). Water Chemistry and Biochemistry. In Food Biochemistry & Food Processing, edited by Hui, Y.H. USA: Blackwell Publishing.
- Chodak, D.A. (2007) Antioxidant properties of different fruit seeds and peels, *Acta Sci. Pol., Technol. Aliment*. 6(3): 29-36
- Choi, Y. Y., Osada, K., Ito, Y., Nagasawa,T., Choi, M.R. and Nishizawa, N. (2005). Effect of dietary protein of Korean foxtail millet on plasma adiponectin, HDL-cholesterol, and insulin levels in genetically type 2 diabetic mice. *Biosc. Biotechnol. Biochem*. 69:31–37.
- Chopra, K. and Neelam, M. (2004) Health and Population – Perspectives and Issues. 27(1): 40–48.
- Córdova, K. R. V. (2005). Características físicas e químicas da casca do maracujá amarelo (Passiflora edulis Flavicarpa Degener) obtida por secagem. Boletim CEPPA. 23(2): 221-230.
- Cupples, L. A., Gillman, M. W (1995). "Protective effect of fruits and vegetables on development of stroke in men." *Journal of the American Medical Association*. 273: 1113-1117
- Dabbah, R., Edwards, V.M. & Moats, W.A. (1970). Antimicrobial Action of Some Citrus Fruit Oils on Selected Food-Borne Bacteria. Applied Environmental Microbiology, 19: 27−31.
- Dagenais, G., Yusuf, S., (2000). "Vitamin E supplementation and cardiovascular events in high-risk patients: The Heart Outcomes Prevention Evaluation Study Investigators." *New England Journal of Medicine*. 342: 154-160.
- Dave, J.M., An, L.C., Jeffery, R.W., & Ahluwalia, J.S. (2009). Relationship of attitudes 467 toward fast food and frequency of fast-food intake in adults. Behaviour and Psychology. 16(6): 1164-1170

- Dayakar, R. B., Patila ,J .V., Rajendraprasad ,M.P., Nirmal Reddy K., Desai, A.D., Kulkarni, S.S., Sahoo, A.k., Ranveer, R.C., Dandge, P.B. (2010). Effect of Supplementation of Malted Ragi Flour on the Nutritional and Sensorial Quality Characteristics of Cake".*Adv J Food Science Technology.* 2(1):67-71.
- Desai, A.D., Kulkarni, S S., Sahu, A.K., Ranveer, R.C. and Dandge, P.B. (2010). Effect of supplementation of malted ragi flour on the nutritional and sensorial quality characteristics of cake. *Adv. J. Food Sci. Tech*. 2(1):67-71.
- Desai, A.D., Kulkarni, S.S., Sahoo, A.K., Ranveer, R.C., Dandge, P.B. (2010)."Effect of Supplementation of Malted Ragi Flour on the Nutritional and Sensorial Quality Characteristics of Cake".*Adv J Food Sci Technol*. 2(1): 67-71.
- Dev, S.R.S. and Raghavan, V.G.S. (2012). Advancements in drying techniques for foods, fiber and fuel. Drying Technology.30, 1147-1159.
- Devi, P. B.,Vijayabharathi, R., Sathyabama,S., Malleshi, N.G. and Priyadarisini, V.B. (2011). Health benefits of finger millet (Eleusine coracana L.) polyphenols and dietary fiber: a review. *J. Food Sci. Technol*. DOI: 10.1007/s13197-011-0584-9
- Dhabekar, A. & Chandak, A. (2010). Utilization of banana peels and beet waste for alcohol production. *Asiatic Journal of Biotechnology Research*, 1: 8–13.
- Djaeni, M. (2008). Energy efficient multistage zeolite drying for heat sensitive products. Doctoral Thesis Wageningen University, The Netherlands, ISBN:978-90-8585-209-4
- Dormond, H., Boschini, C. & Rojas Bourrillon, A. (1998). Effect of two levels of ripe banana peel on milk production by dairy cattle. Agronomia Costarricense, 22: 43−49.
- Dowell, M.D. (2007)." A Review of the Fruit and Vegetable Food Chain."63
- Duda-Chodak A., Tarko T. (2007). Antioxidant properties of different fruit seeds and peels. *Acta Sci. Pol., Technol. Aliment*. 6(3): 29-36.
- Dykes, L., Rooney, L. W. (2006)." Sorghum and Millet Phenols and Antioxidants" *Journal of Cereal Science*.44:236-251.
- Emaga, T.H., Andrianaivo, R.H., Wathelet, B., Tchango, J.T. & Paquot, M. (2007). Effects of the stage of maturation and varieties on the chemical composition of banana and plantain peels. Food Chemistry, 103: 590−600.
- Essien, J.P., Akpan, E.J., Essien, E.P. (2005). Studies on Mould growth and biomass production using waste banana peel. *Bioresearch Technology*. 96: 1451-1456.
- Fanimo, A.O. & Odu, S. (2006). Effect of ripe plantain peel (Musa cv) on growth and carcass performance of growing rabbits. Pertanika. *Journal of Tropical Agricultural Science*, 19: 89−93.
- Fat'hi, M.R. & Zolfi, A. (2012). Removal of Blue 56 by Orange Peel from the Waste Water. *The Journal of Chemical Health Risks*, 2: 7−14.
- Friedman M. (2007). Chemistry, biochemistry, and dietary role of potato polyphenols. *Journal of Agricultural and Food Chemistry*. 45(5):1523-1540.
- Gautam, H.R. & Guleria, S.P.S. 2007. Fruit and Vegetable Waste Utilization. Science Tech Entrepreneur. January, 2007.
- Godbey, G., Lifset, R., & Robinson, J. (2010). No Time To Waste: An Exploration of Time 502 Use, Attitudes Towards Time, and the Generation of Municipal Solid Waste. Social 503 Research, 65(1), 101-140. 504 505.

- Hawlader, M.N.A., Ed. Hii, C.L., Jangam, S.V., Chiang, C.L., Mujumdar, A.S. (2013) Drying of food products under inert atmosphere using heat pump, in Processing and drying of foods, vegetables and fruits. 7(1): 69-82.
- Hawlader, M.N.A., Perera, C.O., Tian, M. (2006). Drying of guava and papaya: Impact of different drying methods. Drying Technology. 24: 77-87.
- Huang, L., Zhang, M., Mujumdar, A. S., Sun, D., Tan, G., & Tang, S. (2012). Studies on decreasing energy consumption for a freeze-drying process of apple slices. Drying Technology, 27(9): 938-946.
- Indira, R. and Naik, M.S. (1971). Nutrient composition and protein quality of some minor millets. *Indian. J. Agric. Sci*., 41: 795-797.
- Ito, K., Ozasa, H., Noda, Y., Arii, S. and Horikawa, S. (2008). Effects of free radical scavenger on acute liver injury induced by D- galactosamine and lipopolysaccharide in rats. Hepatol. Res. 38:194–201.
- Jabs, J., & Devine, C. (2006). Time-scarcity and Food-choices: An Overview. Appetite. 47: 196-204.
- Janagi.S and Lakshmi U.K. (2008). Banana rich in potassium. *Indian Journal of Nutrition and Dietetics*. 33(3): 142-147
- Javed, S., Javaid, A., Mahmood, Z., Javaid, A. & Nasim, F. (2011). Biocidal activity of citrus peel essential oils against some food spoilage bacteria. *Journal of Medicinal Plants Research*, 5: 3697−3701.
- Jimenez-Escrig, A., Rincon, M., Pulido, R. & Saura-Calixto, F. (2001). Guava fruit (Psidium guajava L.) as a new source of antioxidant dietary fibre. *Journal of Agricultural and Food Chemistry*, 49: 5489–5493.
- Judy, T. A., Amnon, L., Claude, T. E., Alvin, S. M. (2005). Analysis based on RAPD and ISSR markers reveals closer similarities among Citrullus and Cucumis species than with Praecitrullus fistulosus (Stocks) Pangalo. Genetic Resources and Crop Evolution.52: 465–472.
- Karuppaswamy, P., Kanchana, S., Hemalath, G., Muthukrishnan, N. (2012). "Development and Evaluation of Kodo Millet and Little Millets Based Boli", *Ind. J. Nutrition and Dietetics*.49, 150.
- Kaur, S., Charanjit. (2008).Antioxidants in fruits and vegetables – the millennium's health. *International Journal of Food Science & Technology*. 36(7):703–725
- Klopi, A., Schoolmeester, D., Dekker, M., & Jongen, W.M.F. (2013). To Cook or Not To Cook: A Means-End Study for Motives of Choice of Meal Solutions. Food Quality and 464 Preference. 18: 77-88.
- Kobylecki, J., Camila, M. (2015). Genetically high plasma vitamin C, intake of fruit and vegetables, and risk of ischemic heart disease and all-cause mortality: a Mendelian randomization study. *American Journal for Clinical Nutrition*. 101(6):1135-1143.
- Krishna, C. & Chandrasekaran, M. (1996). Banana waste as substrate for alpha-amylase production by Bacillus subtilis (CBTK 106) under solid-state fermentation. Applied Microbiology and Biotechnology, 46: 106–111.

- Krishna, C. (1999). Production of bacterial cellulases by solid state bioprocessing of banana wastes. Bioresource Technology, 69: 231–239.
- Krokida, M.K. and Philippopoulos, C. (2005) rehydration of dehydrated foods. Drying Technology. 23: 799-830.
- Kujala, T., Loponen, J. & Pihlaja, K. (2001). Betalains and phenolics in red beetroot (Beta vulgaris) peel extracts: extraction and characterisation. Zeitschrift fur Naturforschung -C, 56: 343−348.
- Kumar.S.K.P., Debjit Bhowmik., Duraivel. S., Umadevi, M. (2012). Traditional and Medicinal Uses of Banana. Journal of Pharmacognosy and Phytochemistry. 1(3): 51-52.
- Kuti, J.O, and H.B. Konuru. (2005). Effects of genotype and cultivation environment on lycopene content in red-ripe tomatoes. *J. Sci. Food Agric*. 85: 560-564
- Kwan ,M.L., Block, G., Selvin, S., Month, S., Buffler, P.A. (2004) Food Consumption by children and the Risk of Childhood Acute Leukemia . *American Journal of Epidemiology.* 160: 1098-1107.
- Labuza, T., Meister. (2011) "An Alternate Method for Measuring the Heating Potential of Microwave Susceptor Films". *J. International Microwave Power and Electromagnetic Energy* 27 (4): 205–208.
- Lampe, W.J. (1999). Health effects of vegetables and fruit: assessing mechanisms of action in human experimental studies. *American Journal of Clinical Nutrition*.70 (3) 475s-490s.
- Lanciotti, R., Gianotti, A., Patrignani, F., Belletti, N., Guerzoni, M. E. & Gardini, F. (2004). Use of natural aroma compounds to improve shelf life and safety of minimally processed fruits. *Trends in Food Science and Technology*, 15: 201−208.
- Larrauri, J.A., Ruperez, P. & Saura-Calixto, F. (1996). Antioxidant activity from wine pomace. *American Journal of Enology and Viticulture*. 47: 369–372.
- Lee W.K. (2003). Major Phenolics in Apple and Their Contribution to the Total Antioxidant Capacity. *J. Agric. Food Chem.*, 2003, *51* (22): 6516–6520
- Lestienne, I., M. Buisson, V. Lullien-Pellerin, C. Picq and S. Trèche. (2007). Losses of nutrients and anti-nutritional factors during abrasive decortication of two pearl millet cultivars (Pennisetum glaucum). *Food Chem*. 100:1316–1323.
- Liu S. (2000). Fruit and vegetable intake and risk of cardiovascular disease: the Women's Health Study. *American Journal for Clinical Nutrition*.72(4): 922-928
- Liu, H.R. (2003) Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *American Journal for Clinical Nutrition*.78(3): 517-520
- Liu, S.K., and Kader, A.A. (2000). Pre-harvest and post-harvest factors influencing vitamin C content of horticultural crops. *Postharv. Biol. Technol*. 20: 207-220.
- Liu, T.J., Wei, Q.K.,Liao, C.W., Hang, M.J., Wang, T.H.(2011) Microbiological quality of 18 degrees ready-to-eat food products sold in Taiwan. *Int. J. Food Microbiol*. 80, 241–250.
- Mahon, D., Cowan, C., & McCarthy, M. (2006). The Role of Attitude, Subjective Norm, Perceived Control and Habit in the Consumption of Ready-meals and Takeaways in Great Britain. Food Quality and Preference.17: 474-481.

- Mal, B., Padulosi, S., Ravi, S.B. (2010) Minor Millets in South Asia: Learnings from IFAD-NUSProject in India and Nepal; Bioversity International: Rome, Italy; M.S. Swaminathan Research Foundation: Chennai, India. p. 185.
- Malmberg, A., Theander, O. (2004). Free and conjugated phenolic acids and aldehydes in potato tubers. *Swedish Journal of Agricultural Research*. 14:119-125.
- Maniyan, A., John, R., Mathew, A. (2015).Evaluation of Fruit Peels for Some Selected Nutritional and Anti-Nutritional Factors. *Emer Life Sci Res*. 1(2): 13-19.
- Marchello, J.M., Liapis, A. (2010). Advances in Modeling and Control of Freeze Drying, pp. 217-244, in A.S. Mujumdar (Ed.) Advances in Drying, Vol. 3, Hemisphere, Washington.
- Medeiros, R.G., Soffner, M.L.A.P., Thome, J.A., Cacais, A.O.G., Estelles, R.S., Salles, B.C., Ferreira, H.M., Lucena-Neto, S.A., Silva, F.G. & Filho, E.X.F. (2000). The production of hemicellulases by aerobic fungi on medium containing residues of banana plant as substrate. Biotechnology Progress, 16: 522–524.
- Michael, D., Miedema. (2015). Association of Fruit and Vegetable Consumption During Early Adulthood With the Prevalence of Coronary Artery Calcium After 20 Years of Follow-Up The Coronary Artery Risk Development in Young Adults (CARDIA) Study. *American Journal for Clinical Nutrition*. 73(3): 56-67
- Miller, D.L.; Castellanos, V.H.; Shide, D.J.; Peters, J.C.; Rolls, B.J. (2008). Effect of fat-free potato chips with and without nutrition labels on fat and energy intakes. *American J ournal of Clinical Nutrition.* 6(8): 282-290.
- Minton, E.B.S.,(2012) Former ENAFS program coordinator, Department of Family, Youth and Community Sciences, University of Florida Institute of Food and Agricultural Sciences, Gainesville, FL 32611.
- Monro, J.A. (2009) Available carbohydrate and glycemic index combined in new data sets for managing glycemia and diabetes. *Journal of the Science of Food and Agriculture*. 1 (2): 71-82.
- Mujumdar, A.S., Wu, Z., (2008). Thermal drying technologies-Cost-effective innovation aided by mathematical modeling approach. Drying Technology, 26: 146-154.
- Naska, A., Orfanos, P., Trichopoulou, A., May, A.M., Oveervad, K., Jakobsen, M.U. (2011). Eating out, weight and weight gain. A cross-sectional and prospective analysis in the context of the EPIC-PAMACEA study. *International Journal of Obesity*. 35:416-426.
- Nesrine, G.R., Catherine, B., Nabil, K. and Nourthene, B.M. (2015) effect of Air-Drying temperature on kinetics of quality Attributes of lemon (citrus limon cv. lunari) peels. Drying technology. *An International Journal*, DOI: 10. 1080/07373937.2015.1012266.
- Njoroge, S.M., Koaze, H., Karanja, P.N. & Sawamura, M. (2005). Volatile constituents of redblush grapefruit (Citrus paradisi) and pummel (Citrus grandis) peel essential oils from Kenya. *Journal of Agriculture and Food Chemistry*, 53: 9790–9794.
- Nazneen, N.B., Handigol, J.A., Bala, R.S., Mal, B., Padulosi, S. (2012). Nutritional and Technological Advancements in the Promotion of Ethnic and Novel Foods Using the Genetic Diversity of Minor Millets in India. Indian J. Plant Genet. Resour. 23, 82–86.
- Osarumwense, L.O. Okunrobo, E.G Uwumarongie-ilori (2013). Phytochemical screening, proximate and elemental analysis of Citrus sinensis peels (l.) Osbeck, *J. Appl. Sci. Environ. Manage*. 17: 47-50.

- Padam, B.S., Tin, H.S., Chye, F.Y., Abdullah, M.I. (2012) Banana by-products: an under-utilized renewable food biomass with great potential, Association of food scientists & Technologists spinger 1.
- Padulosi, S.; Thompson, J.; Rudebjer, P. (2015) Fighting Poverty, Hunger and Malnutrition with Neglected and Underutilized Species *(NUS): Needs, Challenges and the Way Forward; Bioversity International: Rome, Italy.
- Parashar, S., Hitender Sharma., Munish Garg. (2014) Antimicrobial and Antioxidant activities of fruits and vegetable peels: A review. *Journal of Pharmacognosy and Phytochemistry*. 3 (1): 160-164
- Park, K. O., Ito,Y., Nagasawa, T., Choi, M.R., and Nishizawa, N., (2008). Effects of dietary Korean proso-millet protein on plasma adiponectin, HDL cholesterol, insulin levels, and gene expression in obese type 2 diabetic mice. *Biosc. Biotechnol. Biochem*. 72(11):2918– 2925.
- Pedreno, M.A. & Escribano, J. 2001. Correlation between antiradical activity and stability of betanine from Beta vulgaris L roots under different pH, temperature and light conditions. *Journal of the Science of Food and Agriculture*, 81: 627–631.
- Pradhan, A., Nag, S. K. and Patil, S. K., Curr. Sci., 2010, 98(6), 763–765
- Prasad, A.G.D., Pushpa, H.N. (2007). Antimicrobial activity of potato peel waste. Asian Journal of Microbiology, Biotechnology and Environmental Sciences. 9(3):559-561.
- Puravankara, D., Boghra, V. & Sharma, R.S. (2000). Effect of antioxidant principles isolated from mango (Mangifera indica L.) seed kernels on oxidative stability of buffalo ghee (butter-fat). *Journal of the Science of Food and Agriculture*, 80: 522–526.
- Quatromoni, P. A., Copenhafer, D. L. (2002). "The internal validity of a dietary pattern analysis: The Framingham Nutrition Studies*". J. Epidemiol. Community Health*. 56: 381-388.
- Rahman.T (2013). RTE and RTC Foods - A New Era in the Processed Food Industry "With Special Reference to MTR". *International Journal of Management and Social Sciences Research (IJMSSR)* ISSN: 2319-4421. 2 (5):63-67
- Rahuramulu, N., Madhavan Nair, K., Kalyanasundaram, S. (2003). A Manual of Laboratory Techniques. National Institute of Nutrition. Hydrabad. 23-45.
- Rashidkhani, B., Lindblad, P., Wolk, A. (2005). Fruit, Vegetable and Risk of Renal Cell Carcinoma: A Prospective Study of Swedish Women. *International Journal of Cancer*. 113: 451-455.
- Ratti,C. (2001). Hot air and freeze-drying of high-value foods: a review *Journal of Food Engineering*. 49 (4):311–319)
- Ravi, K., Rajasekaran, S., Subramanian, S. (2005). Antihyperlipidemic effect of Eugenia jambolana seed kernel on streptozotocin-induced diabetes in rats. Food and Chemical Toxicology. 43: 1433-1439.
- Ravindran, G. (1992). Seed proteins of millets: amino acid composition, proteinase inhibitors and in vitro digestibility. *Food Chem*., 44(1): 13-17.
- Reyes, A., Bubnovich, V., Bustos, R., Vasquez, M., Vega, R. and Scheuermann, E. (2010). Comparative study of different process conditions of freeze drying of 'Murtila' berry. Drying Technology. 28, 1416-1425.

- Rickman, J.C., D.M. Barrett, and C.M. Bruhn. (2007). Review: Nutritional comparison of fresh, frozen, and canned fruits and vegetables. Part 1: Vitamin C and B and phenolics compounds. *J. Sci. Food Agric*. 87: 930-944.
- Rodríguez Montealegre, R., Romero Peces, R., Chacón Vozmediano, J.L., Martínez Gascueña, J., García Romero, E. (2014). Phenolic compounds in skins and seeds of ten grape Vitis vinifera varieties grown in a warm climate. J. Food Compos. Anal. 19: 687–693.
- Rowayshed, A. Salama, M. Abul-Fadl, S. Akila- Hamza, A.M. Emad (2013). Nutritional and Chemical Evaluation for Pomegranate (Punica granatum L.) Fruit Peel and Seeds Powders by Products. *Middle East J. Appl. Sci.* 3:169-179.
- Sablani, S.S. (2006) Drying of fruits and vegetables: Retention of Nutritional/Functional. Drying Technology. 24:123- 135.
- Sandhu, S.K., Oberoi, H.S., Dhaliwal, S.S., Babbar, N., Kaur, U., Nanda, D. & Kumar, D. (2012). Ethanol production from Kinnow mandarin (Citrus reticulata) peels via simultaneous saccharification and fermentation using crude enzyme produced by Aspergillus oryzae and the thermotolerant Pichia kudriavzevii strain. Annals of Microbiology, 62:655–666.
- Sattar, A. & Mahmud, S. (1986). Citrus oil, composition of monoterpenes of the peel oil of orange, kinnow, and lemon. *Pakistan Journal of Science and Industrial Research*. 29: 196−198.
- Schieber, A., Stintzing, F.C., Carle, R. (2001) By-products of plant food processing as a source of functional compounds-recent developments. *Trends in Food Science and Technology*. 12(11):401-413.
- Schippers, R.R. (2012). African indigenous vegetables, an overview of the cultivated species. Revised edition on CDROM. National Resources International Limited, Aylesford, United Kingdom
- Schwartz, S.E., Levine, R.A., Weinstock, R.S., Petokas, R.S., Mills, C.A. & Thomas, F.D. (1988). Sustained pectin ingestion: effect on gastric emptying and glucose tolerance in noninsulin dependent diabetic patients. *American Journal of Clinical Nutrition*, 48: 1413−1417.
- Shukla, K. and Srivastava, S. (2011). Evaluation of finger millet incorporated noodles for nutritive value and glycemic index. J. Food Sci. Technol. DOI: 10.1007/s13197-011-0530-x
- Singh, N., Rajini, P.S. (2014) Free radical scavenging activity of an aqueous extract of potato peel. Food Chemistry. 85:611–616.
- Snehal, P. and Madhukar, K. (2012). Quantitative estimation of biochemical content of various extracts of *stevia rebaudiana* leaves. Asian Journal of Pharmaceutical and Clinical Research, ISSN: 0974-2441.Vol 5, Issue 1. pp: 115-117.
- Singh, S., Siraj, P., Shamim, M., Verma, A., Agarwal, A., Srivastava, B. (2013). "Development and Standardization of High Protein Corn Incorporated with Kidney Bean and Lentil Flour, 45th Annual National Conference of NIN. 127.
- Sotillo, D., Hadley, M., Wolf-Hall, C. (2008). Potato peel extract a nonmutagenic antioxidant with potential antimicrobial activity. *Journal of Food Science*. 63(5):907-910.
- Stone, H and Siddel, J.L. (1993). Sensory evaluation practices. San Diego, GA: Academic press.
- Subramanian and viswananthan. (2007). "A Study on Millets Based Cultivation and Consumption In India", International Journal of Marketing, Financial Service and Management Research. 2(4): 4-5.

- Suman, T.A.B., Sharma, D. (2013). “A Division of Livestock Products Technolog. Indian Veterinary Institute. 3: 23.
- Tahir, A. & Sarwar, S. (2012). Effect of cultural condition on production of ethanol from rotten apple waste by Saccharomyces cerevisiae straining. Canadian Journal of Applied Science, 2: 187–195.
- Takhellamban, R. D., Chimmad, B .V. (2015). Ready – to – cook millet flakes based on minor millets for modern consumer. *J Food Technol* 4(1):64–69
- Tasirin, S.M., Puspasari, I., Sahalan, A.Z., Mokhtar, M., Kamal, M., Ghani, A., and Yaakob, Z. (2014). Drying of citrus sinesnsis peels in an inert fluidized bed: kinetics, Microbiological Activity, Vitamin C, and Limeonene Determination. Drying Technology: *An International Journal*. 32:497-508.
- Tewari, H.K., Marwaha, S.S. & Rupal, K. (1986). Ethanol from banana peels. Agricultural Wastes, 16: 135–146.
- The World Health Report (2002) - Reducing Risks, Promoting Healthy Life.
- Thomas, B., Ed. (2004). Manual of Dietetic Practice. Oxford, Blackwell Publishing.
- Tripathy, P.P. and Kumar, S. (2009). Influence of sample geometry and rehydration temperature on quality attributes of potato dried under open sun and mixed-mode solar drying. *International journal of green energy*. 6: 143-156.
- Ulep, L.J.L. & Santos, A.C. 1995. Growth performance of Pekin ducks fed with golden snail and fresh banana peelings. Tropicultura, 13: 135−138.
- Valvarde,V.I., Periago, M.J., Provan,G., and Chesson.A., (2014). Phenolic compounds, lycopene and antioxidant activity in commercial varieties of tomato. J. Sci. Food Agric. 82: 323-330.
- Veena, P.S. (2003). Health benefits of kodo milliets. *International Journal of Research in Chemistry and Environment*. 3(2):102-106. ISSN 2248-9649.
- Velazquez, M., Hernandez, A., Martin, A., Aranda, E., Gallardo, G., Bartolome, T., and Codoba, M.G. Quality assessment of commercial paprika. International assessment of commercial paprikas. International assessment of commercial paprika. 49: 830-839.
- Verma, V and Patel, S. (2013). Production Enhancement, Nutritional Security and Value Added Products of Millets of Baster Region of Chhattisgarh. *International Journal of Research in Chemistry and Environment*.3: 85.
- Whitney, E. and Rolfes, S. (2010). Understanding nutrition. Belmont, Ca., USA, West/Wadsworth. Eighth ed. (ed. W. Rolfes).
- Wihelm.,Luther, R., Dwarya, A., Suter and Gerald H., Brusewitz. (2009). Drying and Dehydration. Chapter 10 in Food & process Engineering Technology. St. Joseph, Michigan ASAE. 259-284.
- Zhang, D. & Hamauzu, Y. 2004. Phenolic compounds and their antioxidant properties in different tissues of carrots. *Food Agriculture and Environment*. 2: 95−100.
- Zhang.M.(2009) Trends in microwave-related drying of fruits and vegetables. *Trends in Food Science & Technology*. 17(10):524–534.

http://www.medicalnewstoday.com/articles/283006.php
http://www.who.int/elena/titles/fruit_vegetables_ncds/en/
https://cals.arizona.edu/fps/sites/cals.arizona.edu.fps/files/cotw/Grapes.pdf
https://extension.usu.edu/files/publications/publication/FN-330.pdf
https://www.organicfacts.net/health-benefits/vegetable/health-benefits-of-potato.html
http://www.doctorshealthpress.com/food-and-nutrition-articles/mango-peel-could-contain-hidden-benefits
http://www.livestrong.com/article/467346-cucumber-peel-benefits/

APPENDIX I

ESTIMATION OF PHYTIC ACID

Phytic acid is a common storage form of phosphorus in seeds and is also considered as an antinutritional factor. The complexing of phytic acid with nutritionally essential elements and the possibility of interference with proteolytic digestion have been suggested as responsible for anti-nutritional activity. The phosphorus is phytic acid is not nutritionally available to the monogastric animals. Phytic acid also interferes with calcium and iron absorption. Hence, estimation of phytic acid in food grains becomes essential especially in cereals.

PRINCIPLE

The phytic acid is extracted with trichloroacedic acid and precipitated as ferric salt. The iron content of the precipitate is determined colorimetrically and the phytate phosphorus content calculated from this value assuming a constant 4 Fe: 6 P molecular ratio in the precipitate.

MATERIALS

1. 3% Trichloroacedic acid
2. 3% sodium sulphate in 3% TCA
3. 1.5 N NaOH
4. 3.2 N HNO_3
5. $FeCl_3$ solution
6. 1.5 M potassium thiocyanate
7. Standard Fe $(NO_3)_3$ solution

PROCEDURE

1. Weigh a finely ground sample estimated to contain 5-30 mg phytate P into a 125 ml Erlenmeyer flask.
2. Extract in 50 ml 3% TCA for 30 min with mechanical shaking with occasional swirling by hand for 45 min.
3. Centrifuge the suspension and transfer a 10 ml aliquot of the supernatant to a 40 ml conical centrifuge tube.
4. Add 4 ml of $Fecl_3$ solution to the aliquot by blowing rapidly from the pipette.
5. Heat the contents in a boiling water-bath for 45 min. If the supernatant is not clear after 30 min, add one or two drops of 3% sodium sulphate in 3% TCA and continue heating.
6. Centrifuge (10-15min) and carefully decant the clear supernatant.
7. Wash the precipitate twice by dispersing well in 20-25 ml 3% TCA, heat in boiling water-bath for 5-10 min and centrifuge.
8. Repeat washing with water.
9. Disperse the precipitate in few ml of water and 3 ml of 1.5 N NaOH with mixing.
10. Bring volume approximately 30 ml with water and heat in boiling water-bath for 30 min.
11. Filter hot (quantitatively) through a moderately retentive paper Whatman NO. 2.
12. Wash the precipitate with 60-70 ml hot water and discard the filtrate.

13. Dissolve the precipitate from the paper with 40 ml hot 3.2 N HNO_3 into a 100 ml volumetric flask.
14. Wash paper with several portions of water, collecting the washings in the same flask.
15. Cool flask and contents to room temperature and dilute to volume with water.
16. Transfer a 5 ml aliquot to another 100ml volumetric flask and dilute to approximately 70 ml.
17. Add 20 ml of 1.5 M KSCN dilute to volume, and read color immediately (within 1 min) at 480 nm.
18. Run a reagent blank with each set of samples.

STANDARD

Weigh accurately 433 mg Fe $(NO_3)_3$ and dissolve in 100ml distilled water in a volumetric flask. Dilute 2.5 ml of this stock standard and make up to 250 ml in a volumetric flask. Pipette out 2.5, 5, 10, 15 and 20 ml of this working standard into a series of 100 ml volumetric flasks and proceed from step 16.

CALCULATION

Find out the µg iron present in the test from the standard curve, and calculate the phytate P as per the equation.

Phytate P mg/100 g sample = µg Fe × 15/ Weight of sample (g)

APPENDIX II

STANDARDIZED RECIPE PROCEDURE

ADAI

Ingredients

Kuthiraivali-100g	Green gram dhal 150g
Thinai -100g	Bengal gram dhal -150g
Samai-100g	Rice – 130g
Cholam-100g	Cumin – 20g
Red gram dhal – 150g	Salt – to taste

Method

- Clean and grind all the above ingredients into coarse powder using mixie, mix well. Salt was added while making batter.
- The prepared RTE adai mix was stored in air tight zip lock covers.

Preparation of recipe from RTE mix

- From that take 100g of RTE adai mix in a bowl add 200 ml of water and add salt to batter and mix well. Heat a tawa and pour one full ladle of batter and rotate in circle to make round adai.
- Drizzle oil or ghee in corner of adai, cook until edges becomes brown and edges starts to leave tawa, carefully flip the adai and cook for another 30 seconds.

VEGETABLE PULAV

Ingredients

Kuthiraivali- 200g	Biriyani masala-40g
Thinai-200g	Ginger garlic-20g
Samai-200g	Cloves, cinnamon- 20g
Cholam-200g	Oil-20ml
Carrot- 50g	Salt – to taste
Beans- 50g	

Methods

- All the four millets are cleaned thoroughly to separate mud and stone.
- The vegetables like carrot and beans were dried under sun to remove moisture.
- Ginger and garlic were dried and powdered.
- Mix all the raw ingredients thoroughly except salt and store in air tight zip lock cover.

Preparation of recipe from RTE mix

- To make a vegetable pulav took 100g of RTE vegetable pulav mix, add 250 ml of water and salt. Cook in a cooker.
- If needed oil can be added to increase palatability.

CHAPPATI

Ingredients

Kuthiraivali- 125g
Thinai-125g
Samai-125g
Cholam-125g
Wheat flour- 500g

Salt- to taste

Method

- Clean all the above raw ingredients to separate mud and stone.
- Grind into fine powder and sieve and store in air tight zip lock cover.

Preparation of recipe from RTE mix

- To make chappati, take 100g of RTE chappati mix in a bowl and add salt.
- Add 25 ml of lukewarm water little by little and make a soft dough. If needed, oil can be added to increase the softness.
- Heat a tawa and make chappati.

APPENDIX III

Score card for Development of RTE millet mixes with fruit and vegetable peel

Name of the Judge: Date:

Product Name:

Attributes	standard	Variation-1	Variation-2	Variatin-3
Appearance				
Color				
Taste				
Flavor				
Texture				
Over all acceptability				

Note

Like extremely (9) Dislike slightly (4)

Like very much (8) Dislike moderately (3)

Like moderately (7) Dislike very much (2)

Like moderately (7) Dislike extremely (1)

Like slightly (6)

Neither like nor dislike (5)

Comments: Signature of the Judge

APPENDIX – IV

ETHICAL CLEARANCE CERTIFICATE

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam
Institute for Home Science and Higher Education for Women
University
(Estd. u/s 3 of UGC Act 1956)

11th March 2016

To
Ms. Santhoshini P
Department of Food Science and Nutrition
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Madam,

Ref : Your proposal No. IHEC/15-16/FSN/06 entitled "Development of RTE millet mixes with fruit and vegetable peel" submitted for approval of the IHEC

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/15-16/FSN/06 entitled "Development of RTE millet mixes with fruit and vegetable peel" submitted by you. The Approval number for the same is AUW/IHEC/FSN-15-16/XMT-06.

We wish you all the best in your research endeavours.

Regards,
11/3/16
Dr.P.R.Padma
Member Secretary

Institutional Human Ethics Committee
Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore