PHYSICOCHEMICAL CHARACTERISTICS OF PUREES USING SELETCTED VEGETABLES AND FRUITS

By

K.SARANYA

(15PFN012)

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

M. Amirtham 19/4/17
Signature of the
Head of the Department

R. Balasubramanian 8/4/17
Signature of the supervisor

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1. INTRODUCTION

Vegetables and fruits is a part of the human diet in almost any culture of the world. Diets high in vegetables and fruits are widely recommended for their health promoting properties. Vegetables and fruits 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 fibre (Ottawa: Health Canada; 2007).

Vegetables and fruits are an important part of a healthy diet, and variety is as important as quantity. Vegetable and fruits provide all the nutrients for the humans to stay healthy. A diet rich in vegetables and fruits can lower blood pressure, reduce the risk of heart disease and stroke, prevent some types of cancer, lower risk of eye and digestive problems, and have a positive effect upon blood sugar which can help keep appetite in check. Eating a variety of types and colors of produce give a mix of nutrients the body requires. Dark leafy greens; brightly colored red, yellow and orange vegetables and fruits; and cooked tomatoes satieties these requirements (Hung *et al.*, 2004).

Vegetables and fruits should be consumed because of their nutritional and health benefits. Eating a variety of fruits and vegetables ensures an adequate intake of most micronutrients, dietary fibre and essential non-nutrient substances (Sandrine, 2005). Vegetables and fruits are important sources of fiber, vitamins and other biologically active substances that can favorably affect the pathogenesis of breast cancer through several biological mechanisms (AICR, 2007. Eliasse *et al.,* 2012 *and* Farvid *et al.,* 2016). Vegetables and fruits have a great potential to improve the nutrition and thereby health of consumers as most are good sources of vitamins, minerals and proteins and are needed for the proper functioning and development of the human body (Wills *et al.,*1998). Vegetables and fruits form an important part of a healthy diet and low fruit and vegetable intake constitute a risk factor for chronic diseases such as cancer, Coronary Heart Disease (CHD), stroke and cataract formation (Van Duyn and Pivonka, 2000). The World Health Organisation (WHO, 2013) advocates a daily intake of 400g of fruit and vegetables for maintaining good health.

Originating from the Andes, tomatoes *(Solanum lycopersicum L.)* were imported to Europe in the 16th century. At present, tomato is common around the world, and has become an economically important crop. Furthermore, tomato plant is used as a model species for introducing agronomically important genes into dicotyledonous crop plants (Paduchuri *et al*., 2010). Tomato fruits, like those of many other plant species are part of our diet, an important source of substances with known beneficial effects on health, including vitamins, minerals and antioxidants (Frusciante *et al.,*2007). Tomato fruit consumption has been associated with a reduced risk of inflammatory processes, cancer and Chronic Non Communicable Diseases (CNCD) including Cardio Vascular Diseases (CVD) such as coronary heart disease, hypertension, diabetes and obesity. Antioxidant metabolites are a group of vitamins, carotenoids, phenolic compounds and phenolic acid with health enhancing effects on our body (Canene-Adams *et al.,* 2005 and Frusciante *et al.,* 2007).

Carrot (*Daucus carota* L.) is a widely grown root vegetable of the Apiaceae family. Carrot is an important source of alpha carotene and beta carotene, the precursors of vitamin A in human nutrition in many countries worldwide (Simon and Wolff, 1987). Carrot constitutes the natural sources of vitamins and mineral nutrients to the body. They are used as nutritional remedies for many patients suffering from different ailments such as diabetes, constipation and stroke (Obeta *et al*., 2011). Carrot and apple to be specific, have been known to contain antioxidants, vitamin A, vitamin C, fiber and carotene which help in boosting immunity of the system and protect the cellular anatomical composition of body (Eni *et al*., 2010; Whitney-Chavex, 2011).

Chilli (*Capsicum annuum* L.) is an important vegetable cum spice crop grown in almost all parts of tropical and subtropical regions of the world. Varieties of chilli are important for their nutritional value, flavor, aroma, texture and colour. Chillies are low in sodium and cholesterol free, rich in vitamin A, vitamin C, vitamin E, a good source of potassium and folic acid (Bosland and Votava, 2000; Wang and Bosland, 2006 and Ince *et al.,* 2010). Green chilli is helpful in the management of burns, psoriasis and chronic migraine. It is also beneficial for heart disorders and diabetes.

Pumpkin (*Curcurbita maxima*) is a popular vegetable in our country. This plant is locally known as Mistikumra (Ahsan *et al*., 2015). Pumpkin is a cultivar of a squash plant, most commonly of *Cucurbita pepo* that is round, with smooth, slightly ribbed skin and

deep yellow to orange coloration (Ferriol and Belen, 2007). Pumpkin is commonly used as a staple food, fruits are consumed in daily cooking and also used in sweet preparation. The fruit juice, young stems, flowers and leaves have many medicinal properties (Saha *et al*., 2011; Asgary *et al*., 2011; Jafarian *et al.,* 2012). Pumpkin is good for preventing osteoporosis and hypertension.

Red beetroot (*Beta vulgaris* L.) is an important vegetable. Red beetroot is widely used in food industry. The high content of minerals, vitamins and pigments present in beetroot have beneficial effect on human organism (Szura *et al*., 2008, Zujko and Witkowska 2009 and Hunter *et al*., 2011). Beetroot is an important vegetable crop available throughout the year in all parts of the world. Beetroots are rich in active, valuable bioactive compounds such as carotenoids, saponins, glycine, betaine, folates, polyphenols and flavonoids (Jastrebova *et al*., 2003; Vali *et al*., 2007).

In India, it is common to eat gooseberries steeped in salt water and turmeric to make the sour fruits palatable. The wild amla is small, while cultivated amla is big, smooth and juicy. Chemical composition of the amla fruit contains more than 80% of water. It has protein, carbohydrate, fiber and mineral and also contains gallic acid which is a potent polyphenol. Vitamin C is important for human beings (Ekta *et al*., 2011 and Brun *et al*., 1987). Amla commonly known as Indian gooseberry, is a wonder herb and one of the precious gift of nature to human health. It belongs to family Euphorbiaciae (Singhm *et al*., 2011). In addition to its tonic and rejuvenating function, ancient Unani literature recommends its use in various diseases also, such as bleeding disorder, digestive system disorder, cardiac and respiratory disorders, liver diseases, urogenital disease and skin problems (Ghani and Advia, 2007).

Psidium guajava L. known as Guava is a medicinal plant belonging to the family Myrtaceae. *P. guajava* is a well known traditional medicinal plant used in various indigenous systems of medicine (Mital *et al.,* 2011). Guava fruit an exotic from the tropics characterized by its appealing flavor and aroma, has been catalogued as one of the most nutritious fruits due to its high content of phytochemicals, especially ascorbic acid (USDA, 2004). Guava and their products are increasing steadily due to consumer's education on their exotic flavors, nutritive value and phytochemical content with potential health effects (FAO, 2004). Guava with high nutrition are included among super fruits, being rich in dietary fiber, vitamins A and C, folic acid; and the dietary minerals,

potassium, copper and manganese. Having a generally broad, low calorie profile of essential nutrients, a single common guava fruit contains about four times the amount of vitamin C as an orange (Shruthi *et al*., 2013).

Strawberry *(Fragaria x ananassa Duch.)* is a soft fruit crop which belongs to the family Rosaceae and genus Fragaria. Strawberries have highly desirable taste, flavor and is an excellent source of vitamins, potassium, fibre and sugars (Sharma and Sharma, 2004). As compared to other berry fruits, strawberries contain a higher percentage of vitamin C, phenolics and flavonoids (Hakkinen and Torronen, 2000). Strawberry is a good source of natural antioxidant. Strawberries help to reduce control morbidity and mortality from chronic diseases, cancer, heart disease and other human diseases.

Date palm *Phenix dactylifer L.* is very important tree in the Arab world. The date itself is a high energy food item (Salalh and Naser, 2000). Dates and their constituents show a role in disease prevention through anti-oxidant, anti-inflammatory, anti-bacterial activity. Antioxidant activity is recognized due to the wide range of phenolic compounds present in dates including p-coumaric, ferulic and sinapic acids, flavonoids, and procyanidins (Mansouri *et al*., 2005 and Gu *et a*l., 2003).

The vegetables and fruits are preserved from age old times in order to consume them during other seasons when they are not available. Many preserved forms are used from ancient times. The preserved forms of vegetables and fruits include pickles, jams, sauce, purees, vathal, vadam, dehydrated salted products, sugar syrupy products, etc. One such method of preserved form of vegetables and fruits includes preparation and preservation of puree.

A puree (or mash) is a cooked food, usually vegetables or legumes, that has been ground, pressed, blended or sieved to the consistency of a soft creamy paste or thick liquid purées overlap with other dishes with similar consistency, such as thick soups, creams and gravies. Purées can be made using a blender, or with special implements such as a potato masher, or by forcing the food through a strainer, or simply by crushing the food in a pot. Purées generally must be cooked, either before or after grinding, in order to improve flavour and texture, remove toxic substances, and/or reduce their water content. It is common to use puree as a meal for toddlers, babies and those unable to chew as sufficiently, (Hamlyn, 2000 and 2012). Many recipes can be done with puree and also that it can be used as an alternative for jam with bread and as a side dish for chapatti, poori,

toppings for pizzas' etc. It can be mainly used as a baby food. As there are very limited studies available on these lines, the present topic is of great concern.

Considering the above mentioned nutritional and health benefits of vegetables and fruits the present investigation entitled **"Physicochemical Characteristics of Purees using Selected Vegetables and Fruits"** has been carried out with the following **objectives:**

- Preparation of puree with fruits and vegetables.
- Sensory evaluation of the puree developed using fruits and vegetables.
- Physical, physicochemical characterisation and phytochemical estimation of the puree.

2. REVIEW OF LITERATURE

The review of the literature pertaining to the study on **"Physicochemical Characteristics of Purees using Seletcted Vegetables and Fruits"** is given under the following headings:

I. Nutritive value of vegetables and fruits
II. Role of puree in nutrition and health
III. Physical and physicochemical characters of puree
IV. Phytochemical properties of puree

I. Nutritive value of vegetables and fruits

Vegetables and fruits are rich source of vitamins, minerals, dietary fiber and phytochemicals. Vegetables and fruits are important component of a healthy diet. According to Dias (2012) vegetables are considered essential for well balanced diets since they supply vitamins, minerals, dietary fiber and phytochemicals. Each vegetable group contains a unique combination and amount of these phyto nutraceuticals, which distinguishes them from other groups and vegetables within their own group, and are widely recommended for their health promoting properties (Slavin and Lloyd, 2012). These reasons historically place them in dietary guidance. Vegetables contain high levels of bioactive components which include phenolics, glucosinolates, vitamin C, vitamin E, carotenoids and selenium (Herr and Buchler, 2010). Slavin and Lloyd (2012) said that the effect of vegetable and fruit consumption on human health is difficult to measure because it is influenced by many factors, including their large variety globally, varying dietary patterns, different effects for vegetables compared with fruits and interactions with other dietary components .

Sufficient intake of vegetables and fruits has been associated with a reduced risk of chronic diseases and body weight management but the exact mechanism is unknown. The World Health Organisation and Food and Agriculture of the United Nation reports recommend adults to consume at least five servings of vegetables and fruits per day excluding starchy vegetables (Dhandevi and Jeewon, 2015). Most countries have their own dietary recommendations that include vegetables and fruits and health administrators, scientists and nutritionists all agree on the potential health benefits of fruits and vegetables in the prevention of a range of chronic diseases such as obesity, type II diabetes and cardiovascular ailments (Gerster, 1991; Weisburger, 1991; Block *et al.,* 1992;

Maynard *et al*., 2003). Consumption of vegetables and fruits has been increasing, due to its nutritional value. Recent findings on the high level of obesity and other diet related health problems in children and awareness among consumption of fresh and processed fruit and vegetable products is increased (Rickman *et al.,* 2007).

High consumption of vegetables and fruits is correlated with lower incidence of some types of cancer and cardiovascular disease (Wang *et al.,* 2012). Avocado (*Persea americana)* with various health benefits is rich in monounsaturated fatty acids and contains high level of antioxidants such as polyphenols, tocopherols and carotenoids (Carvajal *et al.,* 2014).Various reviews have associated low intake of vegetables and fruits with chronic diseases such as cardiovascular diseases, blood pressure, hypercholesterolemia, osteoporosis, many cancers, chronic obstructive pulmonary diseases, respiratory problems as well as mental health. Antioxidant capacity varies greatly among vegetables and fruits. Vegetables, nuts and fruits in the daily diet have been strongly associated with reduced risk for some forms of cancer, heart disease, stroke and other chronic diseases (Prior and Cao, 2000, Tapiero *et al.,* 2002; Duthie *et al*., 2003).

The components present in vegetables and fruits are strong antioxidants and function to modify the metabolic activation and detoxification disposition of carcinogens, or even influence processes that alter the course of the tumor cell (Wargovich, 2000). According to Liu (2004) the health benefits of vegetables and fruits are attributed to the synergy or interactions of bioactive compounds and other nutrients in whole foods. Ezzati *et al*., (2002) recorded that 15% of global disease is attributable to the effects of under nutrition and deficiencies in micronutrients. Vegetables and fruit juices may play an important role in delaying the onset of Alzheimer's disease, particularly among those who are at high risk for the disease (Dai *et al.,* 2006; Morris *et al.,* 2006).

Phytochemicals from vegetables may prevent oxidative stress, induce detoxification of enzymes, stimulate immune system, decrease the risk of cancers, inhibit malignant transformation and carcinogenic mutations and reduce proliferation of cancer cells (Herr and Buchler, 2010; Kestwal *et al.,* 2011). Boeing *et al*., (2012) said that the promotion of vegetable and fruit utilization by nutrition and health policies is a preferable strategy to decrease the burden of several chronic diseases in Western developing societies. Many vegetables and fruits are consumed primarily in their fresh state, some produce such as tomatoes, snap beans, corn, peaches, nectarines and pineapples are

consumed in their processed state (ERS, 2004). Vegetables and fruits prevent certain disease conditions like, Alzheimer's, arthritis, asthma, bone density, birth defects, reduce body weight, brain, cardiovascular disease, cataracts, chronic obstructive pulmonary disease, cognitive, dermatological, diabetes, diverticulosis, eye, gastrointestinal, hypertension, inflammation, life span, longevity, neurodegenerative, obesity, oxidation, skin deficiency.

Tomato is one of the most important vegetables for the food and its product consumption is large and widely included in human diet (Augusto, *et al*. 2011, Nisha, *et al.* 2011). Tomatoes are consumed in the form of its products such as tomato juice, paste, ketchup and puree etc (Cantarelli *et al*. 1993, Shao, *et al*. 2013). Tomatoes and tomato products are consistently associated with a lower risk of several types of cancer (Grieb *et al*., 2009, Zhang *et al*., 2009 and Vallverdú-Queralt *et al.,* 2012). Tomato contain micronutrients, such as potassium, vitamin C, vitamin E and folate (Agarwal *et al.,* 2001). Tomato also contains valuable phytochemicals or bioactive components, mainly phenolic compounds and carotenoids, such as lycopene. Phenolic compounds in tomatoes are mainly represented by flavanones (naringenin glycosilated derivatives) and flavonols (quercetin, rutin and kaempferol glycosilated derivatives) (Stewart *et al.,* 2000, Le Gall *et al.*, 2003, Bahorun *et al.*, 2004 and Slimestad *et al.,* 2008).

Like many other colored vegetables carrot is a gold mine of antioxidants. Carrot rich in bioactive compounds like carotenoids and dietary fibers with appreciable levels of several other functional components have significant health promoting properties. Carotenoids, polyphenols and vitamins present in carrot act as antioxidants, anticarcinogens, and immunoenhancers. Carotenoids widely distributed in orange carrots are potent antioxidants which can neutralize the effect of free radicals. They have been shown to have inhibition mutagenesis activity contributing to decrease the risk of some cancers (Dias, 2012).Reported that carrot is a root vegetable (Krishnan *et al.*, 2011) with carotenoids, flavonoids, polyacetylenes, vitamins and minerals, all of which possess numerous nutritional and health benefits. Besides lending truth to the old age that carrots are good for eyes, carotenoids, polyphenols and vitamins present in carrot also act as immune enhancers. Anti-diabetic, anti-cholesterol and cardiovascular disease lowering, anti-hypertensive, hepato protective, reno protective and wound healing benefits of carrot are also widely studied (Dias, 2014). Carrots rich in vitamins such as vitamin C and K,

thiamine (B1), riboflavin (B2), pyridoxine (B6) and folates (B9) are necessary for metabolism of carbohydrates, proteins and healthy growth USDHHS (2010).

Green chilli is an excellent combination of healthy and essential nutrients. Green chilli is a good source of vitamins A, C, B, E, minerals, iron, magnesium and potassium, dietary fibers and micronutrients. Green chilli play a main role as immunity booster, anti-cancer, anti-ulcer, analgesic, anti-inflammatory, anti-epileptic and anti-hemorrhoidal. Green chilli is helpful in the management of burns, psoriasis and chronic migraine. It is also beneficial for heart disorders and diabetes (Parle and Sushila, 2012). Ahmed and Ramasamy (2000) reported that chillies are most used in preparation of curries, sauces, meat and paste curry mixes and purees. Chilli with mild pungency are also extensively liked for salad and pickling.

Ting zhou *et al.,* (2007) reported that pumpkin is a dicotyledonous seed vegetable with many nutritional components. Pumpkin contains polysaccharides, active protein, essential amino acids, carotenoids and minerals. Pumpkin pulp is used as an anti diabetic, anti hypertensive, anti tumor, immune modulatior, anti bacterial, intestinal anti parasitia and anti inflammator. Pumpkin pulp a dry material is abundant in polysaccharides, which include soluble polysaccharides and insoluble dietary fiber (Xiong, 2000 and Zhang, 2002). Fan and Li (2005) said that pumpkin is an eminent source of many minerals important for human health. Pumpkin is also good for preventing osteoporosis and hypertension. Pumpkin is a high yield vegetable, easy to grow and consequently, inexpensive.

Beetroot is proposed to have beneficial effects in health and disease. Beetroot is a rich source of phytochemical compounds, ascorbic acid, carotenoids, phenolic acids and flavonoids (Georgiev *et al.,* 2010, Kujala *et al*., 2002 and Wootton-Beard *et al*., 2011). Beetroot juice on inflammation is strongly involved in the development and progression of several clinical conditions including coronary heart disease and cancer, beneficial effect of beetroot extract may relate to this anti-inflammatory capacity (Winkler *et al*., 1990). Kumar (2015) said that beetroot is the taproot portion of the beet plant. Beetroot plays an important role in the development and growth of human body. Beetroot has amazing health benefits such as anemia, blood pressure, constipation, gastric ulcer, lowers cholesterol, toxic effects of kidney ailments, liver toxicity or bile, skin disorder and increases sex drive.

Amla fruit is highly nutritious and is one of the richest sources of vitamin C, amino acids and minerals (Srivasuki, 2012). Amla fruit is used as a medicine. There are several chemical constituents like tannins, alkaloids and phenols present in amla. Among all hydrolysable tannins, emblicanin A and B; gallic acid, ellagic acid is reported to possess biological activity. Almost all parts of amla possess medicinal properties, which has been used in Ayurveda. Amla as medicine is used in the treatment of diarrhoea, jaundice, inflammation and several other ailments (Zhang *et al.,* 2003) Krishnaveni and Mirunalini (2010) reported that amla is useful in vitiated conditions of tridosha, diabetes, cough, asthma, bronchitis, cephalalgia, ophthalmopathy, dyspepsia, colic, flatulence, hyperacidity, peptic ulcer, erysipelas, skin diseases, leprosy, haematogenesis, inflammation, anaemia, emaciation, hepatopathy, jaundice, diarrhoea, dysentery, haemorrhages, leucorrhoea, menorrhagia, cardiac disorders, intermittent fevers and premature greying of hair. Swetha and Mohan (2014) elucidated that amla act as an antioxidant, in ulcer prevention, for diabetes, for mental and memory effects, and highlighted on its anti-inflammatory benefits.

Flor De (2005) opined that guava fruit, appealing for its unique tropical flavors, is considered as an excellent source of nutrients and antioxidant phytochemicals, especially ascorbic acid. Priya (2011) recorded that guava is rich in tannins, phenols, triterpenes, flavonoids, essential oils, saponins, carotenoids, lectins, vitamins, fiber and fatty acids. Guava fruit is higher in vitamin C than other citrus. Guava is a super fruit, rich in dietary fiber, vitamins A and C, folic acid and contains dietary minerals like potassium, copper and manganese (Hassimotto *et al.*, 2005). Suchitra *et al.,* (2016) reported that guava fruit without peel is more effective in lowering blood sugar as well as serum total cholesterol, triglycerides and cholesterol and increases cholesterol levels. Guava is medicinally used for anorexia, cerebral ailments, child birth, chorea, convulsions, epilepsy, nephritis, jaundice (Kamath *et al*., 2008).

Strawberry is a good source of natural antioxidant and antioxidant enzymes which provide protection against harmful free radicals. It has a very important role in protecting human health. Strawberries help in controlling morbidity and mortality from chronic diseases. Eating strawberries has been associated with lower incidence and mortality rates of cancer, heart disease and other human diseases (Wang, 2014). Valko (2016) observed that strawberry in addition to these antioxidant enzymes, dietary micronutrients, such as

vitamins C and E, and trace elements, such as copper, iron, selenium and zinc, play an important role in antioxidant and pro-oxidant activities. Strawberry have been shown to alleviate CVD risk factors in clinical studies as well as in animal models of atherosclerosis (Basu *et al.*, 2014).

Al-Gboori and Krepl (2012) quoted that Iraqi dates contain proteins, fats, salts, carbohydrates and vitamins, all in an easily assimilated form. One pound (453 g) of dates supplies 5.33 kilojoules of physiological energy. Phytochemical investigations have revealed that dates contain anthocyanins, phenolics, sterols, carotenoids, procyanidins and flavonoids, compounds known to possess multiple beneficial effects. Dates is an almost excellent source of dietary fiber and contain considerable amounts of minerals, lipids and protein (Dayang *et al., 2014*). Al-Shahib and Marshal (2003) reported that dates contain at least 15 essential minerals, including phosphorus, potassium, sodium, zinc, manganese, magnesium, copper, iron, fluorine and selenium. Folli *et al.,* (2011) explained that dates plays a role in the pathogenesis of micro and macro vascular diabetic complications, the pathophysiology associated with atherosclerosis, neoplasia and neurodegenerative diseases. The increased oxidative stress in subjects with type 2 diabetes is a result of several abnormalities, including hyperglycemia, insulin resistance, hyperinsulinemia and dyslipidemia. Saada *et al*., (2012) said that dates are rich sources of carbohydrates, dietary fibers, certain essential vitamins and minerals. Date is a free radical scavenging, antioxidant, antimutagenic, antimicrobial, anti-inflammatory, gastroprotective, hepatoprotective, nephroprotective, anticancer and immunostimulant activities.

II. Role of puree in nutrition and health

Puree is a processed product which is convenient to use and could retain the original colour and flavour in a semi solid form. It is made from vegetables and fruits. Carrot, apple, potato and banana puree is mostly used as supplementary food infants.

Lucia *et al.,* (2014) reported that carotenoids have antioxidant activity, but few are converted by the body into retinol, the active form of vitamin A. Among the 600 carotenoids with pro-vitamin A activity, the most common are α- and β-carotene. These carotenoids are susceptible to degradation (e.g., isomerization and oxidation) during cooking. The total carotenoid and carotenoid isomers in puree increased after the cooking methods. Cooking the vegetable reduces several of the protective factors such as vitamins, minerals, phytochemicals, antioxidants and enzymes and is a main disadvantage. It is

beyond doubt that cooking induces significant changes in chemical composition and vitamin content, although it depends on the type of cooking. The greater the heat and the longer the time of exposure, the greater is the nutrient destruction (Glia, 2013).

Rao and Rao (2007) and Rodriguez (1999) opined that double bonds in the carbon chain of carotenoids are susceptible to some reactions such as oxidation and isomerisation (*cis–trans*) especially due to light, heat, acids and oxygen; thus causing loss of colour and reduction of biological activity . In the case of isomerisation, the *trans*-isomers are more common and stable in foods while *cis*-isomers are usually formed during food processing (Oliver and Palou, 2000).

Water cooking treatments better preserved the antioxidant compounds, particularly carotenoids. Steamed vegetables maintained a better texture quality than boiled ones, whereas boiled vegetables showed limited discoloration. Fried vegetables showed the lowest degree of softening, even though antioxidant compounds were less retained (Cristiana *et al.,* 2008). Vegetables are commonly cooked before being consumed. Cooking induces significant changes in chemical composition, influencing the concentration and bioavailability of bioactive compounds in vegetables. They also reviewed that vegetables offer lower nutritional quality and also suggested that for each vegetable, a cooking method would be preferred to preserve the nutritional and physicochemical qualities.

Maceiras *et al., (*2007) examined the significant change in apparent viscosity when the fruit purees are heated. This influences velocity and temperature profiles; therefore, it is necessary to have knowledge about the influence of shear rate and temperature on the rheological behaviour of fruit purees. Physical properties of vegetables are also greatly affected by heat treatments. Cooking time almost brings about changes in texture and colour change of vegetables (Waldron *et al.,* 1997 and Turkmen *et al*., 2006). Banana puree undergoes thermal processing at high temperatures during its manufacture. There is a significant change in apparent viscosity when the banana puree is heated. This influences the velocity and temperature profiles, as well as the pressure drop inside the processing equipment (Cynthia *et al*., 2004).

Sobowale *et al.,* (2012) said that the viscometry consistency test and flow index at 30°C, 45°C and 60°C indicated the existence of variations among the samples in terms of viscosity and flow index increase as temperature increases. All tomato paste samples in

the study were non-Newtonian fluids and the apparent viscosity of the paste decreased with temperature increase. Espinosa *et al*., (2011) showed that apple purees had a shear thinning behaviour, presenting a yield stress. Increasing pulp content increased shear thinning behaviour and consistency index. Apparent viscosity and yield stress decreased with decreasing particle size and pulp content. The second heat treatment affected cell wall structure inducing a decrease of the viscosity on the puree and the serum. Therefore controlling the heat treatment parameters is important as they can affect the structural and rheological properties.

III. Physical and physicochemical characteristics of puree

Grabowski (2006) reported that spray-drying, which has bee**n** used for commercial production of functional ingredients from several fruits and vegetables has not yet been used for sweet potato processing. The effects of viscosity reduction of sweet potato puree with alpha-amylase, maltodextrin (MD) addition, with an inlet air temperature on the physicochemical characteristics of spray-dried sweet potato powder was determined**.** Proximate composition, beta-carotene, vitamin C, and mineral analyses were performed. Steady shear rheology of reconstituted powder solutions was also evaluated at different temperatures and shear rates. Spray drying significantly reduced the beta carotene and ascorbic acid contents. Additionally, the all-trans form of beta-carotene was further transformed to the cis-isomers during dehydration. The viscosity of the reconstituted solutions was much lower than that of the puree at the same solid concentration. Rheologically, the reconstituted sweet potato slurries behaved similarly to pregelatinized starch solutions. Thus, spray dried sweet potato powders have a potential to enhance food systems as a thickener despite the need for increased nutrient retention.

Pereira *et al., (*2012) evaluated the physical and physicochemical properties of different brands of traditional, low calorie and sugar-free guava preserves. Analysis indicated that there were differences in the physical and physicochemical properties. Total exclusion of sugar from guava alters the physical and physicochemical properties, making the product redder; even added body and sweetening agents are incapable of conferring properties similar to those of conventional products. Talcott *et al*., (2000) opined that carrot purees were thermally processed with and without the periderm tissue after a long and short blanch time, with and without vacuum deaeration treatments. Carrot puree stored at a temperature of 40 °C for 4 weeks was evaluated for its physicochemical changes affecting antioxidant activity (AOX), and was measured by the coupled oxidation of β-

carotene and linoleic acid assay, and overall quality characteristics. Differences in AOX between treatments before thermal processing and during storage were associated with increased levels of phenolic acids. Samples processed with periderm tissue contained higher levels of phenolic acids, total carotenoids, and sugars than samples processed without periderm tissue. Strained carrot color was adversely affected by a long blanch time compared to a short blanch in treatments with and without periderm tissue, indicating improved color with reduced preprocessing heating.

Physical and chemical parameters of strawberry puree from different cultivars and the effect of freezing on its quality was determined by Galoburda *et al* (2014). The strawberries were processed in a blender until obtaining a homogenous mass. The strawberry puree was analyzed fresh and after storage at –18 °C. The physical and physicochemical content of soluble solids, total phenols and total acids was explicit as citric acid was determined. The content of sugars (sucrose, glucose, and fructose) was evaluated. Content of vitamin C in strawberry puree essentially differed among the types of thermal treatment. The content of anthocyanins was highest in fresh strawberry puree.

Joseph *et al.,* (2016) determined the physicochemical properties of pumpkin pulp and the sensory properties of pumpkin pineapple juice blends. Pumpkin fruit pulp was analyzed for some physicochemical properties such as protein, ash, titratable acidity, pH and minerals (Ca, Na, Zn, K, Mg and Fe). Significant differences ($p<0.05$) existed in TA, ash, pH and moisture contents of the pulps from the round and cylindrical fruits. Marina (2016) studied the physical and microstructure of avocado puree on butter cake. Physical properties including batter specific gravity, volume, colour and image analysis of cellular structure of the crumb were also analyzed. Texture profile analysis was determined using texture analyzer. The results showed that with the increased amount of avocado puree, the batter specific gravity increased while volume of the cakes reduced. The texture profile analysis showed that the cakes became harder as the amount of avocado puree increased, while cohesiveness was not affected. The cellular structure of the crumb exhibited a decrease in the number of air cells while the average cell size increased with addition of avocado puree.

Eke-Ejiofor (2015) evaluated the physical and phyisochemical properties of commonly consumed brands of tomato paste. Six double concentrate tomato paste and a locally processed sample were reviewed. Chemical composition of the samples revealed

that locally processed tomato was the least in total solids, pH, viscosity and lycopene, with Gino tomato brand having the highest lycopene content. All brands of tomato paste showed a significant difference ($p>0.05$) in the chemical parameters.

Santos (2011) reported the rheological behavior of Brazilian Cherry pulp in the range of temperatures used for pasteurization (83 to 97°C). The results indicated that Brazilian Cherry pulp presented pseudo plastic behavior, and the Herschel-Bulkley model was considered more adequate to represent the rheological behavior of this pulp in the range of temperatures. The fluid behavior index (n) varied in the range from 0.448 to 0.627. The effect of temperature on the apparent viscosity was described by an equation analogous to Arrhenius equation, and a decrease in apparent viscosity with an increase in temperature was observed. The puree showed a shear thinning behavior with an appreciable yield stress value, following the trend of Herschel-Bulkley model. The addition of glucose decreased the apparent viscosity and increased the temperature dependency of the flow properties. The pH presented no pattern with respect to its effect on flow characteristics, while temperature and concentration greatly influenced the flow properties (Guerrero *et al*., 1997).

IV. Phytochemical properties of puree

Phytochemical is a colouring agent of vegetables and fruits, so eating brighter colored varieties may have health benefits. There are also several beneficial phytochemicals in colourless or less colourful vegetables and fruits. For example, onion and corn are rich in phytochemicals. Based on their chemical structure, phytochemicals are classified into ten categories. Basically they are subdivided into three main categories i.e. phenolic acids, flavonoids and stilbenes or ligans; these flavonoids are further subdivided into anthocyanins, flavones, flavanones, isoflavones as well as flavonols and flavanols (Hollman, 2005 and Bordia *et al.,*1996 and Briggs *et al.,* 2001).

The impact of achenes on polyphenolic compounds, ascorbic acid and antioxidant activities in strawberry purees at production and after storage at 6 and 22 °C for 8 and 16 weeks was investigated. Strawberry purees were made from flesh, berry and achene-enriched homogenate and contained 0, 1.2, and 2.9% achenes respectively. At production, strawberry purees made from flesh, contained more anthocyanins, *p*-coumaroyl glycosides and ascorbic acids, where as increasing achene levels caused increasing levels of ellagic

acid derivatives, proanthocyanidins, flavonols, total phenolics and antioxidant activities (Kjersti *et al.,* 2007).

The phytochemical properties were evaluated, as well as an assessment made on the safety and potential efficacy of the major phytochemicals present in the puree. Processed noni fruit puree is a potential dietary source of vitamin C, vitamin A, niacin, manganese and selenium. Vitamin C is the major nutrient present in terms of concentration. The major phytochemicals in the puree are iridoids, especially deacetylasperulosidic acid and is present in higher concentrations than vitamin C (Brett *et al.*, 2011). Liu (2004) explained that phytochemical properties, bioactive non-nutrient plant compounds in fruits, vegetables, grains and other plant foods possess health benefits. These compounds prevent many chronic diseases associated with cancer, inflammation, atherosclerosis and aging caused by free radicals (Liu, 2003, 2004; Zern *et al*., 2005). Phytochemical rich foods maintain higher antioxidant levels in blood serum (Cao *et al*., 1998).

Jeanelle and Rui (2004) researched that vegetables and fruits may decrease the risk of chronic diseases, such as cardiovascular disease and cancer, and phytochemicals including phenolics, flavonoids and carotenoids from vegetables and fruits in reducing chronic disease risk. Apple puree is a rich source of phytochemicals and help reduce the risk of some cancers, cardiovascular disease, asthma and diabetes.

Rao (2007) evaluated that phytochemicals in freshly harvested plant foods may be destroyed or removed by modern processing techniques, possibly including cooking. Phytochemicals are chemical compounds such as beta-carotene that occur naturally in plants. Phytochemicals have been used as drugs for millennia. Most phytochemicals have antioxidant activity and protect our cells against oxidative damage and reduce the risk of developing certain types of cancer (Satyanand *et al*., 2010). Alice and Fernanda (2016) showed that phytochemical composition of red coloured fruits is associated with antioxidant activity, shows a protective effect against many chronic diseases. Woolfe (1992) said that sweet potatoes are highly nutritious vegetable, rich in calories and biologically active phytochemicals such as β-carotene, polyphenols, ascorbic acid and dietary fiber. Grubben *et al*., (2004) reported that carotenoids present in pumpkins are among the phytochemical components believed to reduce the risk of developing some degenerative diseases and are responsible for the attractive colour of many vegetables and fruits.

George *et al*., (2012) investigated that effects of consuming fruits and vegetables as puree-based drinks (FVPD) daily on vasodilation, phytochemical bioavailability, antioxidant status and other CVD risk factors. Lopez *et al*., (2014) experimented the order of blending and thermal treatments and the impact on phytochemicals in the purees. This blending-heating order effect was investigated in more depth by performing alternate blending-heating sequences in triplicate on the same batches of broccoli, tomato and carrot puree. For each vegetable and particularly in broccoli, a large proportion of the metabolites detected in the purees was significantly influenced by the blending-heating order, amongst which were potential health-related phytochemicals and flavour compounds like vitamins C and E, carotenoids, flavonoids, glucosinolates and oxylipins. Our metabolomics data indicates that during processing the activity of a series of endogenous plant enzymes, such as lipoxygenases, peroxidases and glycosidases, including myrosinase in broccoli, is key to the final metabolite composition and related quality of the purees.

3. METHODOLOGY

The materials and methods used for the study on **"Physicochemical Characteristics of Purees using Selected Vegetables and Fruits"** is discussed under the following headings:

I. Selection, development and standardization of the puree

II. Sensory evaluation of the puree

III. Physical, physicochemical characterization and phytochemical estimation of the puree

IV. Statistical analysis and interpretation of the data

I. Selection, development and standardization of the puree

Vegetables and fruits are rich in vitamins, minerals and other compounds. Based on the literature and availability of vegetables and fruits, in the study area, four vegetables and four fruits namely carrot, chilli, pumpkin, beetroot, amla, guava, strawberry and dates rich in nutrients and phytochemicals were selected for the study. Puree is a semisolid food. It is made using vegetables and fruits. Puree can be replaced in the recipes during non availability of the vegetables and fruits in a particular season.

Fresh, mature, ripened and intact vegetables and fruits were purchased from the local super market. 100g weighed quantity of fresh fruits and vegetables were taken. Selected vegetables namely tomato, carrot, chilli, pumpkin and beetroot; fruits namely amla, guava and strawberry, dates were soaked in water for 20 minutes to remove the presence of chemicals and soil. The soaked water was discarded. It is again washed thoroughly under the running tap water. This enables to remove the presence of unwanted dust particles, surface soil and micro organisms present in the skin. The peels of the carrot, pumpkin, beetroot and guava were removed using a peeler.

The vegetables and fruits were then cooked in measured volume of water for a stipulated time. Measuring cups were used to measure the amount of water used. A digital timer which has seconds unit was used to record the time taken for cooking the puree. The rise in temperature and the final temperature (in degree Celsius) was measured using a thermometer and recorded. The vegetables and fruits were cooked by closing the lid. So

the loss of nutrients through evaporation was minimised. The amount of water used, the time and temperature taken for cooking each of the vegetable and fruit was standardized after repeated trials. Once the vegetables and fruits were cooked thoroughly they were allowed to cool at room temperature. After cooling, the vegetables and fruits were made into a smooth paste using a blender. The smoothness with no lumps was confirmed by passing the puree through a strainer. To the paste, salt, sugar and spices were added in weighed quantities as per the procedure after repeated trials. The procedure followed for the preparation of the puree is appended (Plate 1 and Appendix I). Figure 1 represents the steps involved in the preparation of the puree.

II. Sensory evaluation of the puree

Sensory evaluation is a scientific method used to evoke, measure, analyze and interpret those responses to products through senses of sight, smell, touch, taste and hearing (Stone and Sidel*.,* 1998). According to Lutz (2008), acceptance testing evaluated the attributes of color, taste, visual appearance and overall acceptability using a nine-point hedonic scale, which was anchored at the ends with extremely liked (9) through extremely disliked (1). The effective characteristic is not the property of the food, but to the subject's reaction to the sensory qualities of foods. This reaction is highly conditioned by a variety of psychological and social factors and in final analysis, plays a vital role in the acceptance and preference of foods (Srilakshmi, 2012).

The developed vegetable and fruit puree were subjected to sensory evaluation. Twenty five semi trained panellists doing post graduation and research in either Food Science and Nutrition and Food Service Management and Dietetics of Avinashilingam Institute for Home Science and Higher education for Women, Coimbatore were selected for evaluating the food product using sensory evaluation. Sensory evaluation was carried out using 9 point hedonic scale and Food Action Rating Scale. The 9 point Hedonic scale has scores form extremely liked to extremely disliked with corresponding scores 9 to 1. The Food Action Rating Scale contains nine statements that best represent the attitude of the panelists towards the product. The prepared puree was subjected to sensory evaluation along with the standard puree. Puree prepared with tomato was used as a standard. The sensory evaluation of each variation of the puree along with the standard was carried out at mid-morning and at mid-evening. Each panelists were given both the hedonic scale score card and food action rating scale and were asked to mark their comments / score for each variation in comparison with standard. Few purees were served along with bread as they

cannot be consumed as such. The score card and the action food rating scale used for evaluation are appended (Plate 2 and Appendix II).

Plate 1

Steps involved in the preparation of puree

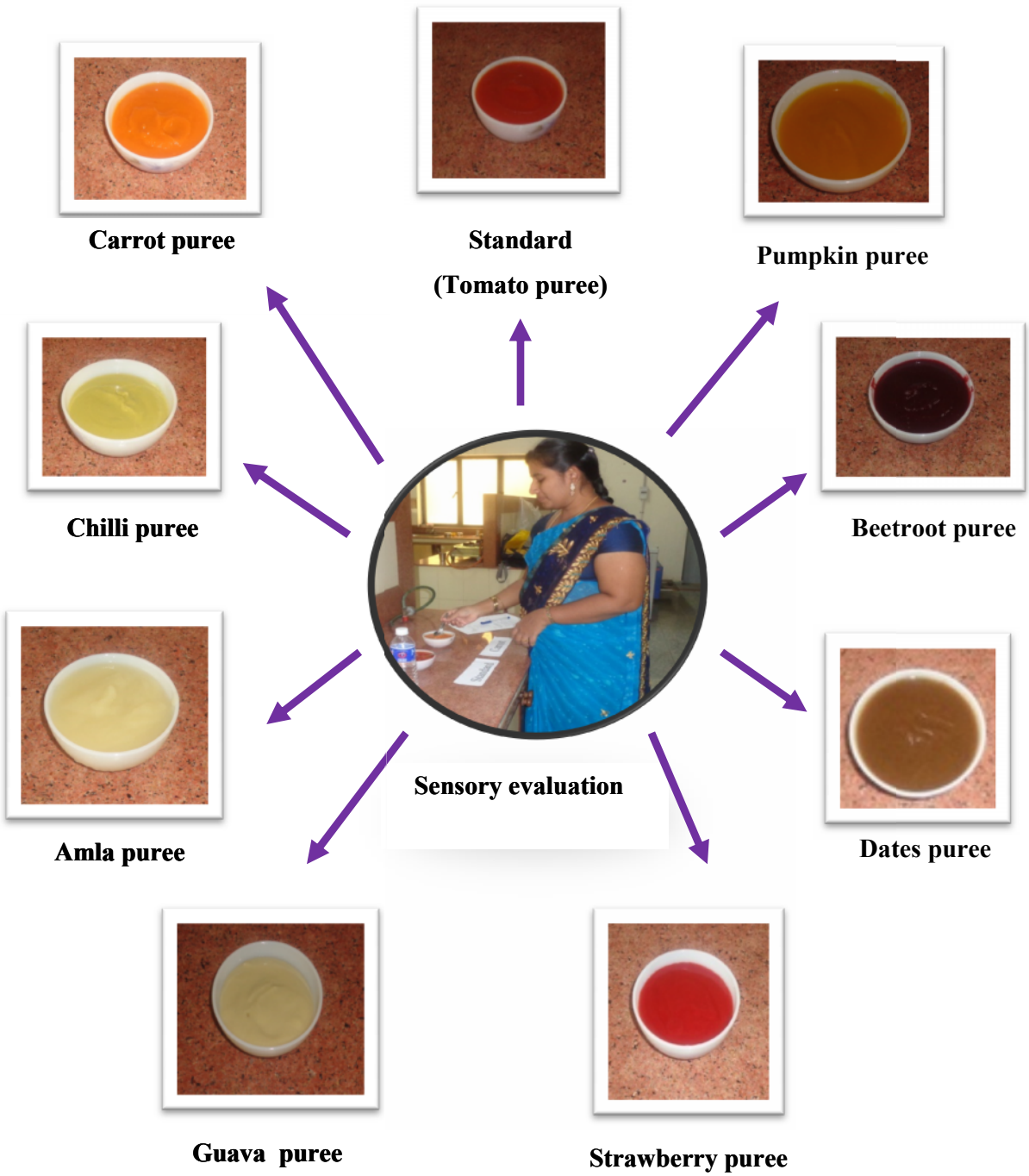

Plate 2

Sensory evaluation of the puree

III. Physical, physicochemical characterization and phytochemical estimation of the puree

Physical, physicochemical and phytochemical analysis was carried out for the all vegetable and fruit puree. The physical and physicochemical characteristics analyzed include ash, moisture, energy, phosphorus, iron, protein, vitamin C, vitamin A, pH, soluble solids, invert sugar / total sugar, titrable acidity and rheological property. The phytochemicals analyzed include tannins, terpenoids, phenols, flavonoids, saponins, quinones, glycosides and coumarins. All the analysis was carried out using the standard procedures in the Nutrition and Foods laboratory of the Department of Food Science and Nutrition of Avinashilingam Institute for Home Science and Higher Education for Women (AOAC, 1990) (Appendix III).

iii.a. Analysis of physical compounds

Rheological property

Rheometry refers to the experimental technique used to determine the rheological properties of materials, that is the quantitative and qualitative relationships between deformations and stresses and their derivatives. The choice of the adequate experimental technique depends on the rheological property which has to be determined. This can be the steady shear viscosity, the linear visco elastic properties (complex viscosity respectively elastic modulus), the elongational properties, etc. of the food products. The rheological properties of the puree was analysed using Brookfield rheometer (AOAC, 2005).

Nutrient analysis

Energy

The working of bomb calorimeter is based on the fact that a known weight of the sample is completely burnt in the apparatus permits the heat developed by the combustion to be absorbed by a definite weight of water. By determining the rise in temperature, it is possible to calculate within close limits, the number of heat units liberated (AOAC, 1990).

Protein

The given sample is digested with concentrated sulphuric acid in a Macrokjeldahl flask when nitrogen gets converted to ammonium sulphate. Ammonia is liberated by the action of strong alkali in a macrokjeldahl steam distillation apparatus.

This nitrogenous substance is converted to ammonium borate by absorbing 2% boric acid and is titrated against N/70 sulphuric acid. The volume of acid required to bring the test sample to the colour of the blank gives the acid equivalent to the ammonia (AOAC, 1990).

Phosphorus

When the ash solution is treated with ammonium molybdate, phosphomolybdic acid is formed. Phosphomolybdic acid is reduced by the addition of 1,2,4 amino naphthol sulphonic acid reagent to produce a blue colour which is apparently a mixture of oxides of molybdenum. The intensity of the colour developed is the measure of phosphorus present in the sample and is measured colorimetrically between 540 to 560 nm (AOAC, 1990).

Iron

The food sample is oxidized with ignition or oxidation. Iron as ferric iron reacts with ammonium thiocyanate or with potassium thiocyanate to give ferric thiocyanate which is red in colour. The red colour developed is a measure of the concentration and is measured colorimetrically at 540nm (AOAC, 1990).

Vitamin A (Carotene)

Carotene present is extracted with petroleum ether and the intensity of the colour of the extract is compared with that of the standard solution using a colorimeter (AOAC, 1990).

Vitamin C

Ascorbic acid is oxidised to dehydro ascorbic acid by bromine water. The excess bromine is removed by aeration. The dehydro ascorbic acid is treated with thio urea and then coupled with 2,4 dinitro phenyl hydrazine and finally treated with 85% sulphuric acid to produce a red colour which is read at 540 mμ calorimetrically (AOAC, 1990).

b. Physicochemical estimation

Moisture

Estimation of moisture is one of the most often performed determinations in food analysis. Moisture is lost when food is heated not much higher than the temperature of boiling water or by allowing to stand overnight over dehydrating agent or by heating over vacuum (AOAC, 1990).

Ash

By continuous heating, the substance gets charred which can be used for the determination of minerals present (AOAC, 1990).

pH

pH is a numeric scale used to specify the acidity or basi city of an aqueous solution. pH is the measurement of H^+ ion activity; it measures active acidity. pH may be determined by measuring the electrode potential between glass and reference electrodes; pH meter is standardized using standard pH buffer (AOAC, 2000)

Soluble solids

Measurement of the refractive index of the test solution at 20°C, using a refract meter and use of tables correlating refractive index with soluble solids content expressed as sucrose, or direct reading of the soluble solids content on the refract meter (AOAC, 2000) .

Total sugar

The presence of sucrose can be detected by determining sugar before and after inversion by copper-reduction method (AOAC, 2000).

Titrable acidity

Titrable acidity is a measure of the acid present in a solution. Titrable acidity can be expressed conveniently in grams acid per 100 gm or per 100 ml as appropriate, by using the factor appropriate to the acid 0.1 N NaOH (AOAC, 2000).

c. Phytochemical estimation

Preparation of extract

5g of the sample was taken and added 10 ml of water. The solution was centrifuged and the supernatant clear liquid was collected for further analysis.

Tannins

About 0.5g of the dried sample was boiled in 20ml of water in a test tube and filtered. A few drops of 0.1% ferric chloride was added and observed for brownish green or a blue black coloration (AOAC, 2005).

Terpenoids

To 0.5 ml of extract, 2ml of chloroform was added and concentrated sulphuric acid was added carefully. Formation of red brown colour at the interface indicates the presence of terpenoids (AOAC, 2005).

Phenols

To 1ml of the extract, 2ml of distilled water followed by few drops of 10% ferric chloride was added. Formation of blue or green indicates presence of phenols (AOAC, 2005).

Flavonoids

To 2ml of plant extract, 1ml of 2N sodium hydroxide was added. Development of yellow colour indicates the presence of flavonoids (AOAC, 2005).

Saponins (Foam test)

5ml sample extract was dissolved in 2.5 ml of dilute water and shaken vigorously till a stable persistent froth was obtained. The froth was mixed with 3 drops of olive oil and shaken vigorously and then emulsion was observed (AOAC, 2005).

Quinones

To 1ml of extract, 1ml of concentrated sulphuric acid was added. Formation of red colour indicates the presence of quinones (AOAC, 2005).

Glycosides

To 2ml of the extract, 3 ml of chloroform and 10% ammonia solution was added. Formation of pink colour indicates the presence of glycosides (AOAC, 2005).

Coumarins

To 1ml of the extract, 1ml of 10% sodium hydroxide was added. Formation of yellow colour indicates the presence of coumarins (AOAC, 2005).

The physical, physicochemical and phytochemical tests were done in triplicates to get concordant values (Plate 3).

Protein estimation

Titrable acidity

Ashing

Moisture

Sample extraction

Rheometer

Plate 3

Physical, physicochemical characterization and phytochemical estimation

IV. Statistical analysis and interpretation of the data

The data obtained was consolidated and tabulated in which mean and standard deviation were computed. One way ANOVA was used to calculate the significance.

Ethical Clearance

The research design and the protocol used in the study was presented for scrutinisation and approval in the Institutional Human Ethics Committee and the ethical clearance approval was obtained. The ethical clearance approval number is AUW/IHEC/FSN-16-17/XMT-04 (Appendix IV). The research design of the study is schematically represented in Figure 2.

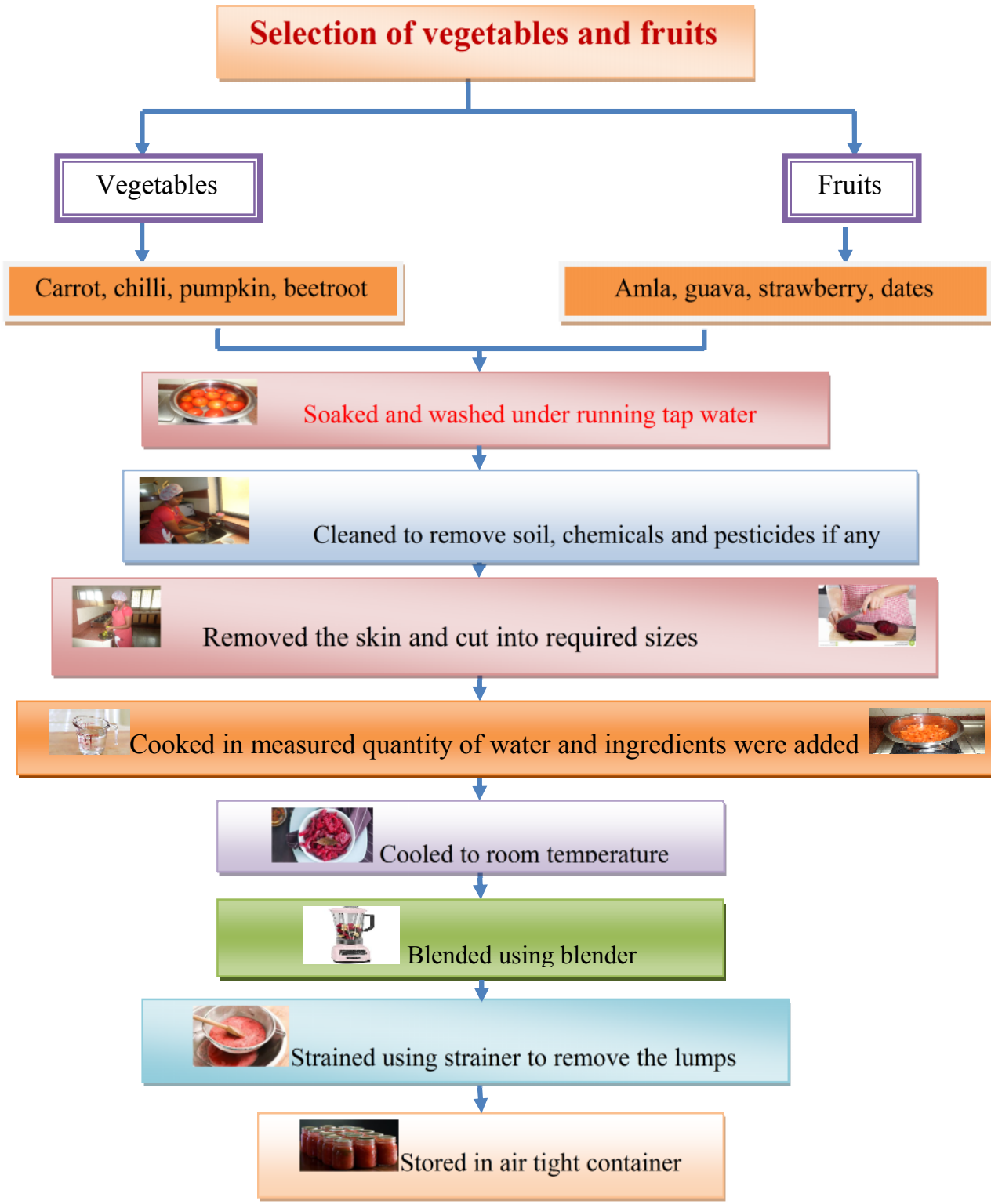

Figure 1

Preparation of the puree

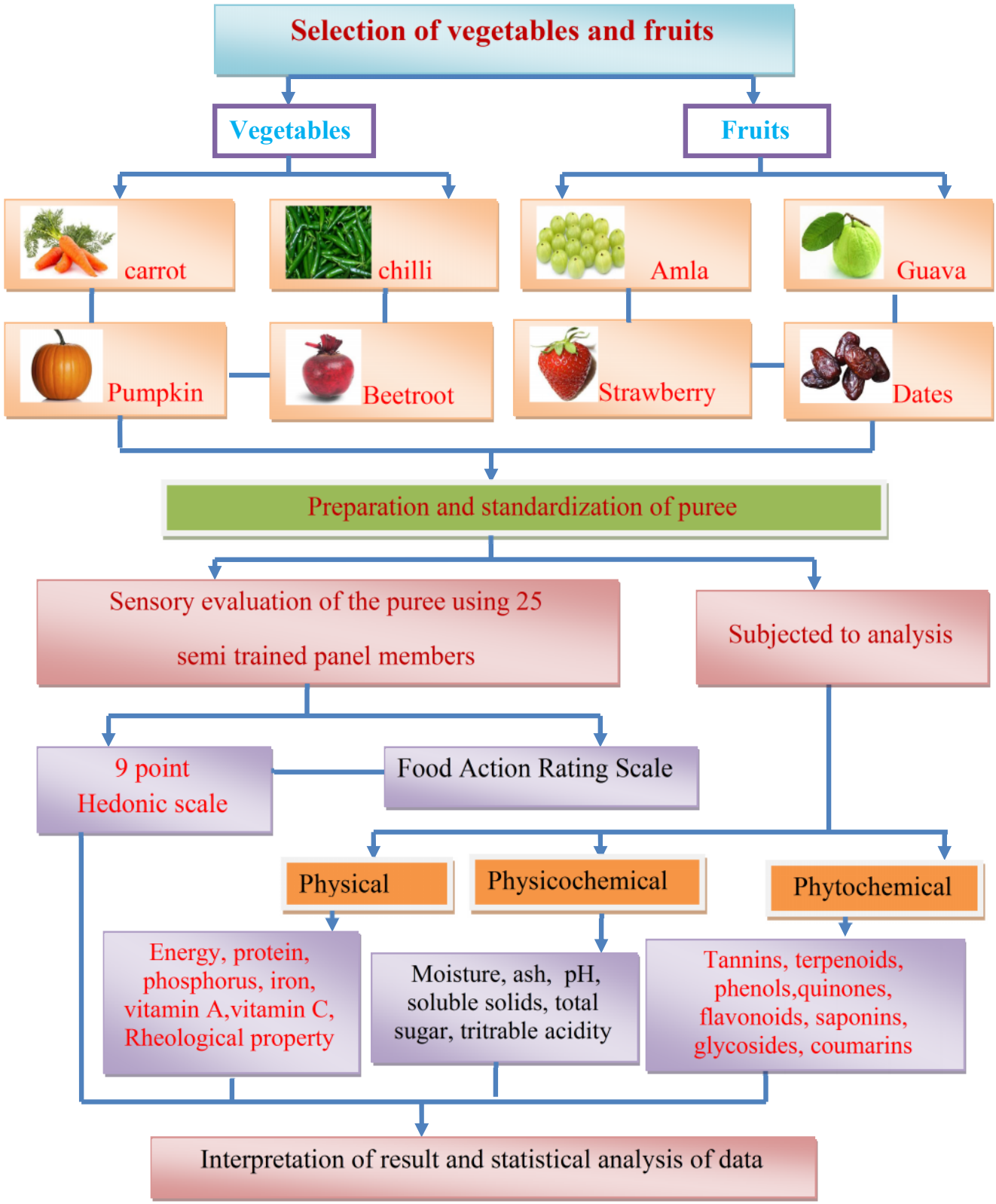

Figure 2

Research Design

4. RESULTS AND DISCUSSION

The results pertaining to the study **"Physicochemical Characteristics of Purees using Selected Vegetables and Fruits"** is discussed under the following headings:

I. Standardization of vegetable and fruit puree
II. Sensory evaluation of the developed vegetable and fruit puree
III. Physical characteristics of vegetable and fruit puree
IV. Physicochemical estimation of vegetable and fruit puree
V. Phytochemical analysis of the puree

I. Standardization of vegetable and fruit puree

The vegetables selected for the puree preparation are carrot (*Daucus carota L*), chilli (*Capsicum annuum L)*, pumpkin (*Curcurbita maxima*) and beetroot (*Beta vulgaris L*) and fruits selected are tomato (*Solanum lycopersicum L)*, amla (*Phyllanthus emblica)*, guava (*Psidium guajava L)*, strawberry (*Fragaria x ananassa Duch*) and dates (*Phenix dactylifer L)*. The cooking temperature, cooking time and water used for the development and standardisation of the puree are recorded and tabulated in Table I.

TABLE I

STANDARDIZATION OF VEGETABLE PUREE

Vegetable	Botanical Name	Water (ml)	Time	Temperature (°C)
Carrot	*Daucus carota L*	300	10 minutes 45 seconds	91°C
Chilli	*Capsicum annuum L*	200	8 minutes 50 seconds	89°C
Pumpkin	*Curcurbita maxima*	150	10 minutes 48 seconds	89°C
Beetroot	*Beta vulgaris L*	250	11 minutes	92°C

It took 10 minutes and 45 seconds to cook the carrot puree, with 300 ml of water and cooking temperature was 91°C. Chilli puree took a very short time of 8 minutes and 50 seconds to cook when compared with other vegetables with 200 ml of water and cooking temperature was 89°C. Pumpkin puree took 10 minutes and 48 seconds for cooking with water 150ml and a temperature of 89°C. The cooking time take for beetroot

puree was very long with 11 minutes, water was 250 ml and cooking temperature was 92°C. This may be due to the thick flesh present in beetroot.

TABLE II

STANDARDIZATION OF FRUIT PUREE

Fruit	Botanical Name	Water (ml)	Time	Temperature (°C)
Tomato	*Solanum lycopersicum L*	300	10 minutes 29 seconds	90°C
Amla	*Phyllanthus emblica*	300	8 minutes 30 seconds	92°C
Guava	*Psidium guajava L*	250	9 minutes 30 seconds	93°C
Strawberry	*Fragaria x ananassa Duch*	30	6 minutes 20 seconds	75°C
Dates	*Phenix dactylifer L*	300	10 minutes 33 seconds	94°C

The fruits namely tomato, amla and dates consumed 300 ml of water to cook the fruit completely whereas guava took 250 ml and strawberry took the least amount of water i.e. 30 ml to cook the fruit completely.

The cooking time was 10 minutes and 33 seconds which was highest for the dates as the fleshy part was more in dates compared with other fruits. This was followed by tomato with 10 minutes and 29 seconds. All other fruits namely guava took 9 minutes and 30 seconds followed by amla with 8 minutes and 30 seconds, strawberry with 6 minutes and 20 seconds. It was observed that the cooking time was less than 10 minutes for the fruits guava, amla and strawberry. This may be due to more amount of water content in the fruits.

Strawberry cooked at a temperature of 75° C which was the minimum temperature taken when compared with other fruits. Tomato cooked at 90° C followed by amla with 92° C, guava with 93°C and dates with 94° C. Dates took the highest temperature to get cooked.

II. Sensory evaluation of the developed vegetable and fruit puree

Texture is a primary attribute that, appearance, taste and aroma, comprises the sensory quality of foods. Sensory evaluation can be considered as an objective method of product quality assessment. The analysis of the chemical composition and the physical

properties of certain food products afford information about the nature of stimuli perceived by the consumer, but not about the sensation experienced in its consumption (Brant *et al*., 2003 and Arora *et al*., 1995).

The vegetable and fruit puree are easy to prepare. Acceptability of the food is also important criteria in any situation. Therefore acceptability trials of the developed puree were carried out. The developed puree was subjected to sensory evaluation by 25 semi trained panelists. The various parameters based on which the puree were tasted by panelists include appearance, colour, taste, flavor and texture. A nine point Hedonic Scale and Food Action Rating Scale was chosen for the evaluation. The overall acceptability for each puree was assessed by considering the different criteria for the sensory evaluation.

II.b. Sensory evaluation of the vegetable puree

Table III and Figures 3 to 8 shows the sensory evaluation of vegetable puree.

TABLE III

SENSORY EVALUATION OF VEGETABLE PUREE

Criteria	Standard	Carrot puree	Chilli puree	Pumpkin puree	Beetroot puree	F value
Appearance	8.08 ± 0.27	8.2 ± 0.57	7.88 ± 0.43	8.04 ± 0.2	8.32 ± 0.55	0.053^{ns}
Colour	8.24 ± 0.59	8.2 ± 0.64	8.08 ± 0.27	7.68 ± 0.47	8.2 ± 0.57	0.532^{ns}
Taste	8.2 ± 0.57	7.68 ± 0.47	7.6 ± 0.5	7.96 ± 0.2	7.84 ± 0.59	13.45**
Flavor	8.04 ± 0.2	7.76 ± 0.43	7.92 ±0.27	7.76 ± 0.43	7.64 ± 0.48	3.215*
Texture	8.16 ± 0.62	7.68 ± 0.37	7.44 ±0.50	7.72 ± 0.45	7.92 ± 0.27	5.612**
Over all acceptability	8.00 ± 0.57	8.08 ± 0.27	7.96 ±0.2	7.28 ± 0.2	8.00 ± 0.28	0.929^{ns}

** - Significant at 1% level; * - Significant at 5% level; ns - Not significant

Vegetable puree prepared from standard using tomato and different vegetables using carrot, chilli, pumpkin and beetroot were discussed in terms of appearance, colour, taste, flavor, texture and overall acceptability. The mean scores for appearance was highest with 8.32 in beetroot puree followed by 8.2 in carrot puree, 8.04 in pumpkin puree and 7.88 in chilli puree. The mean scores for colour was highest with 8.20 in carrot puree and beetroot puree, followed by 8.08 in chilli puree and 7.68 in pumpkin puree. The mean scores for taste was highest with 7.96 in pumpkin puree followed by 7.84 in beetroot puree, 7.68 in carrot puree and 7.6 chilli puree. The mean score for flavor was highest with

7.92 in chilli puree followed by 7.76 in carrot puree and pumpkin puree and 7.64 in beetroot puree. The mean scores for texture was highest with 7.92 in beetroot puree followed by 7.72 in pumpkin puree, 7.68 in carrot puree and 7.44 in chilli puree. The mean scores for over all acceptability was highest with 8.08 in carrot puree followed by 8.00 in beetroot puree, 7.96 in chilli puree and 7.28 in pumpkin puree.

It was observed that the mean scores for appearance of the carrot and beetroot puree was high when compared with the standard. Whereas the mean scores for appearance of pumpkin and chilli puree was in par with the standard tomato puree. The mean scores of carrot and beetroot puree for colour was 8.2 which was comparable with the standard tomato puree of 8.24. The taste, flavour and texture of the puree revealed that all the puree scored less when compared with the standard. The mean scores for overall acceptability showed that carrot and beetroot puree had a similar score as that of the standard tomato puree.

It was observed that there was no significant difference in appearance and colour of the vegetable puree when compared with the standard. The taste and texture of the vegetable puree was significant at 1% ($p<0.01$) level when compared with standard. Flavor of the vegetable puree was significant at 5% ($p<0.05$) level when compared with standard. Statistical analysis revealed there was no significant difference in overall acceptability when compared with the standard. These results reveal that the puree developed with vegetables can be well accepted in means of taste and overall acceptability and hence can be consumed as standard.

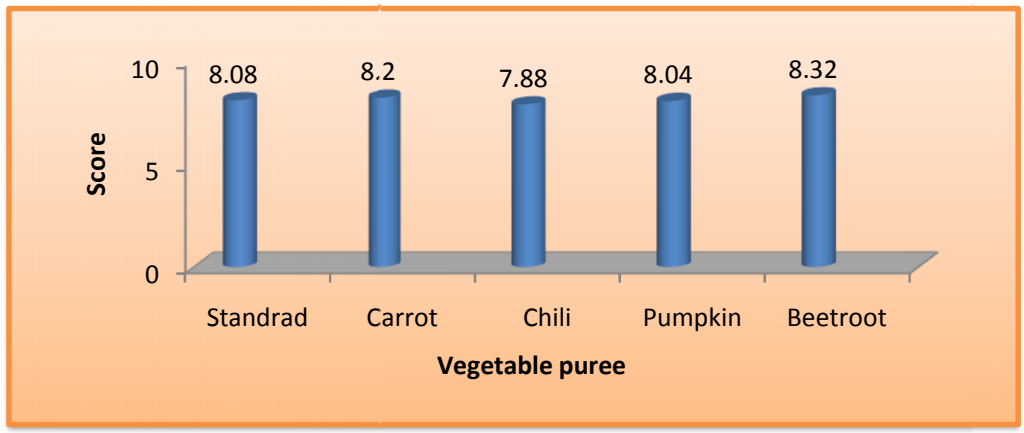

FIGURE 3

APPEARANCE OF THE VEGETABLE PUREE

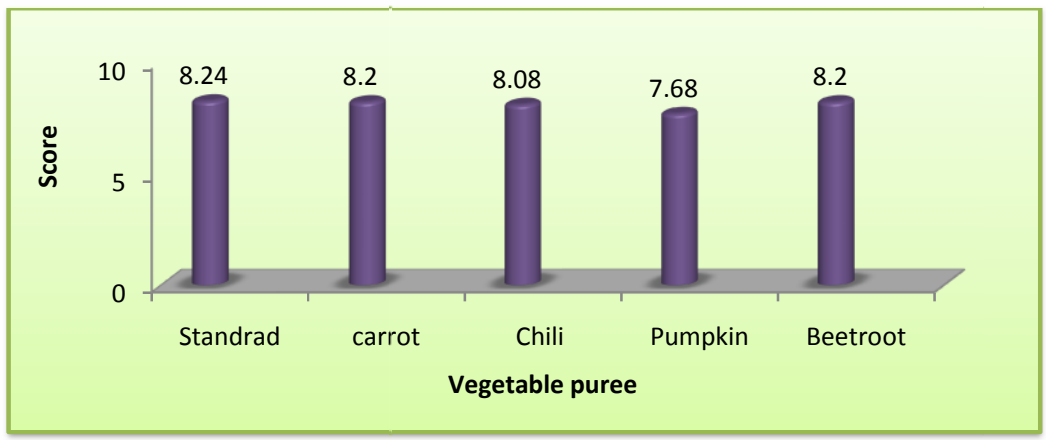

FIGURE 4

COLOUR OF THE VEGETABLE PUREE

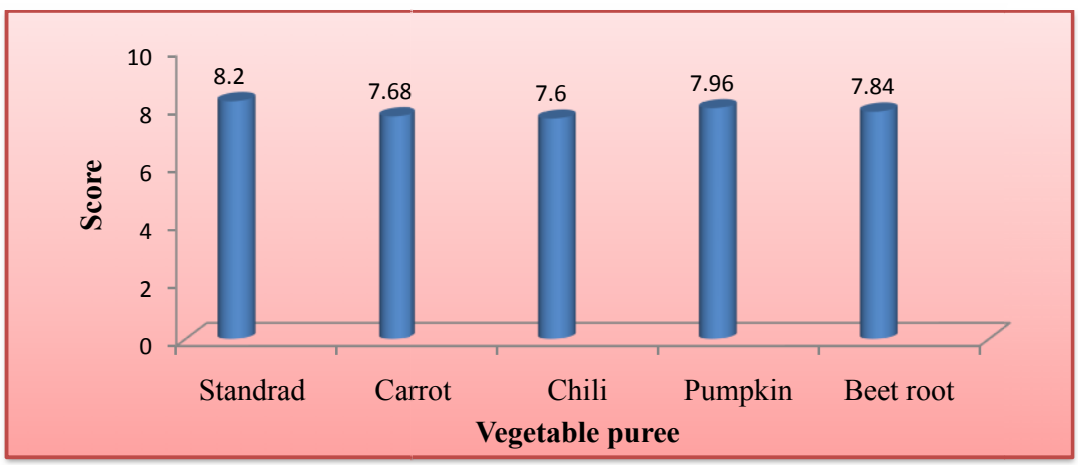

FIGURE 5

TASTE OF THE VEGETABLE PUREE

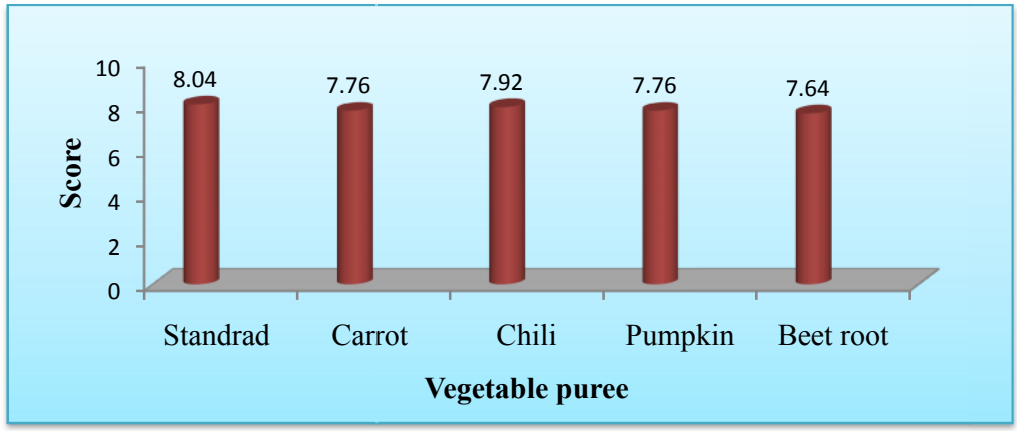

FIGURE 6

FLAVOR OF THE VEGETABLE PUREE

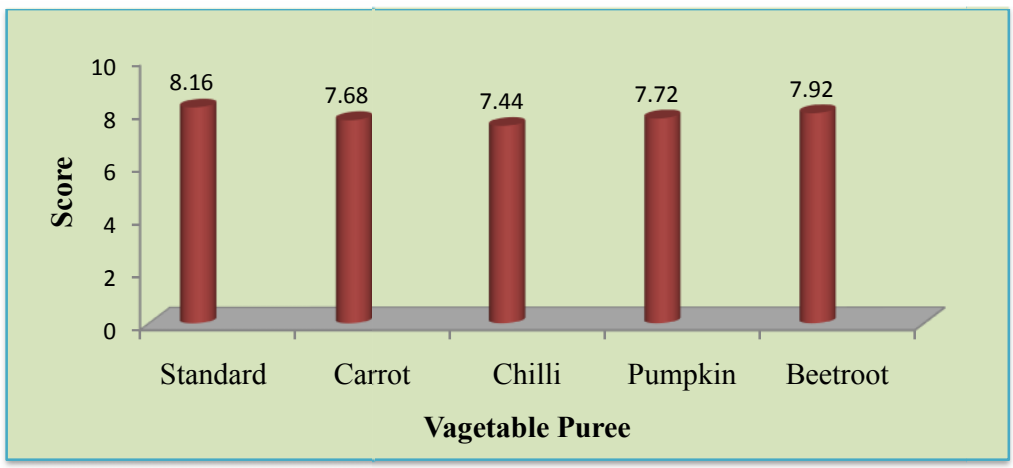

FIGURE 7

TEXTURE OF THE VEGETABLE PUREE

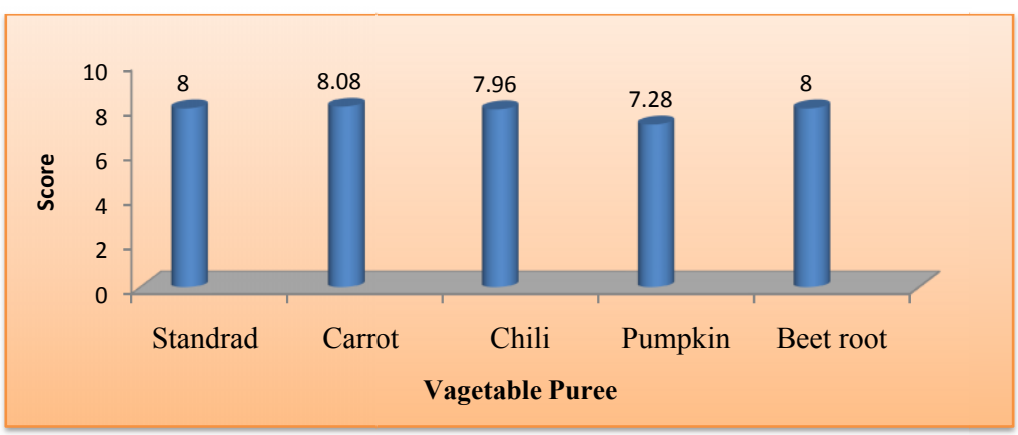

FIGURE 8

OVERALL ACCPETABLLITY OF THE VEGETABLE PUREE

II. b. Sensory evaluation of the fruit puree

The puree prepared from fruits namely amla, guava, strawberry and dates are discussed in terms of appearance, colour, taste, flavour, texture and over all acceptability. The results of the sensory evaluation of fruit puree are presented in Table IV and from Figures 9 to 14.

TABLE IV

SENSORY EVALUATION OF THE FRUIT PUREE

Criteria	Standard	Amla puree	Guava puree	Strawberry puree	Dates puree	F value
Appearance	8 ± 0.28	7.96 ± 0.2	7.88 ± 0.33	8.6 ± 0.5	8.2± 0.57	0.561^{ns}
Colour	8.24 ± 0.59	7.68 ± 0.45	7.8 ± 0.40	8.72 ± 0.45	8.08± 0.27	3.60*
Taste	8.08 ± 0.27	7.48 ± 0.50	7.64 ± 0.48	8.64 ± 0.48	8.16± 0.34	0.742^{ns}
Flavor	8.12 ± 0.33	7.6 ± 0.5	7.92 ± 0.2	8.56 ± 0.50	8.36± 0.48	5.60**
Texture	8.36 ± 0.56	8.04 ± 0.2	8.04 ± 0.2	8.72 ± 0.45	8.28± 0.54	3.492*
Over all acceptability	8.16 ± 0.62	7.52 ± 0.50	7.76 ± 0.43	8.76 ± 0.43	8.24± 0.59	5.821**

** - Significant at 1% level; * - Significant at 5% level; ns - Not significant

The mean scores for appearance was highest with 8.6 in strawberry puree followed by 8.2 in dates puree, 7.96 in amla puree and 7.88 in guava puree. The mean scores for colour was highest with 8.72 strawberry puree followed by 8.08 in dates puree, 7.8 in guava puree and 7.68 in amla puree. The mean scores for taste was highest with 8.64 in strawberry puree followed by 8.16 in dates puree, 7.64 in guava puree and 7.48 in amla puree. The mean scores for flavor was highest with 8.56 in strawberry puree followed by 8.36 in dates puree, 7.92 in guava puree and 7.6 in amla puree. The mean score for texture was highest with 8.72 in strawberry puree followed by 8.28 in dates puree, 8.04 in amla puree and guava puree. The mean scores for overall acceptability was highest with 8.76 in strawberry puree followed by 8.24 in dates puree, 7.76 in guava puree and 7.52 in amla puree.

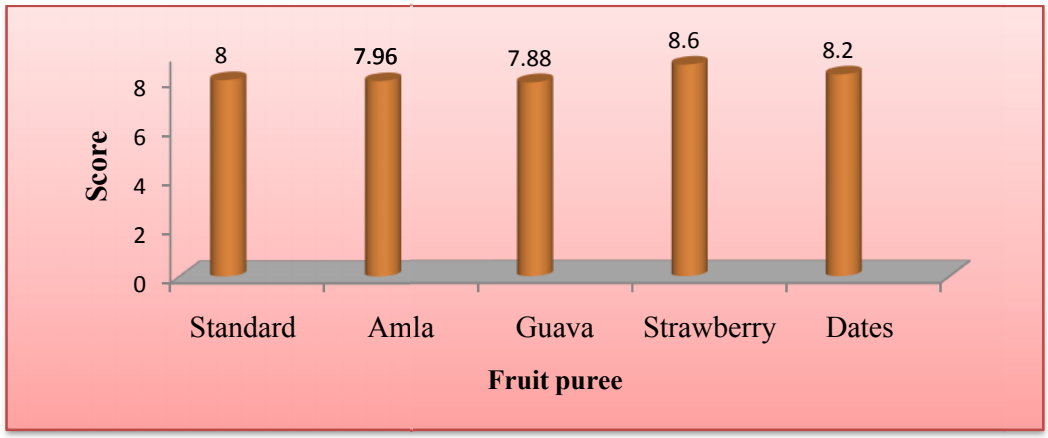

FIGURE 9

APPEARANCE OF THE FRUIT PUREE

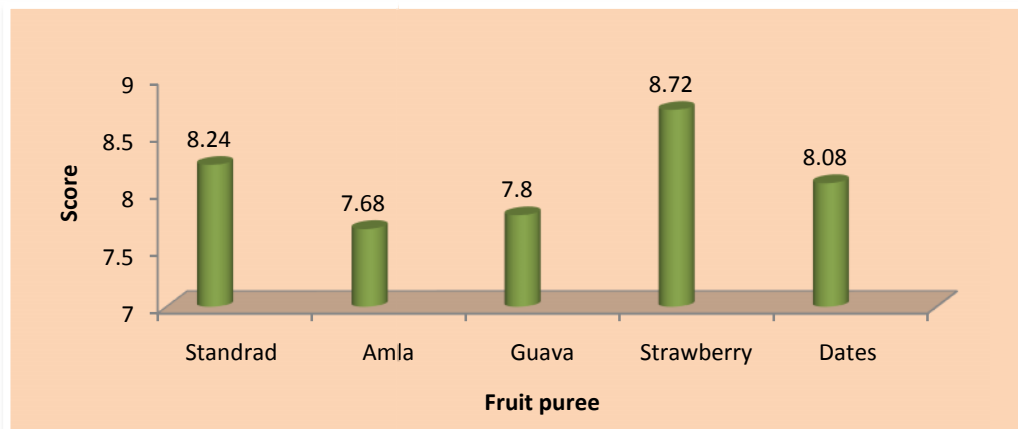

FIGURE 10

COLOUR OF THE FRUIT PUREE

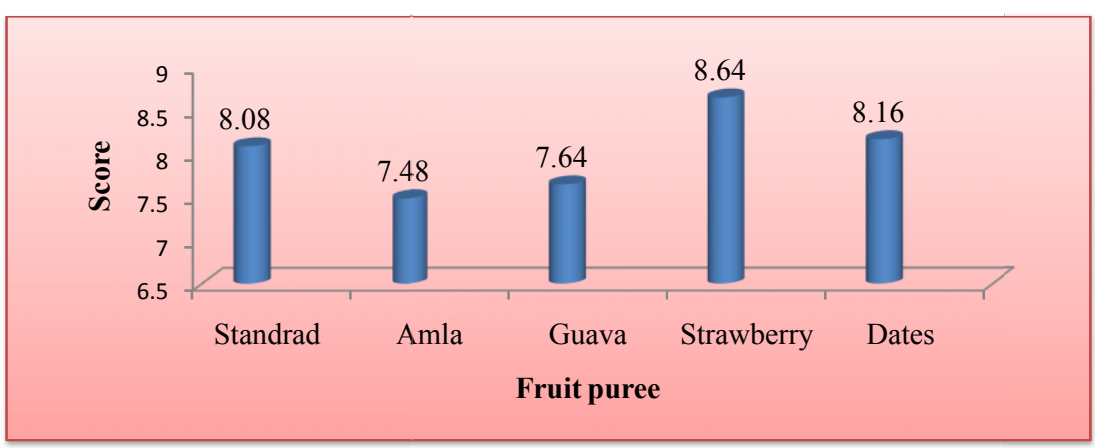

FIGURE 11

TASTE OF THE FRUIT PUREE

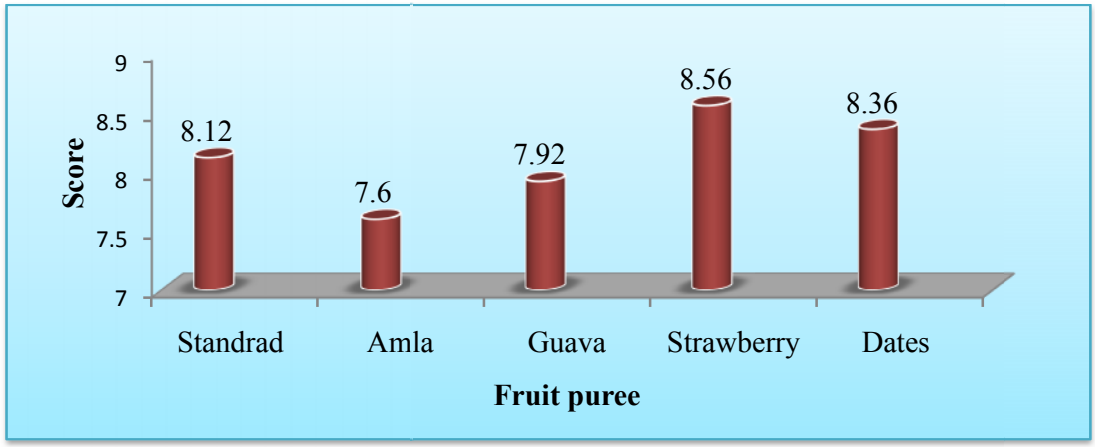

FIGURE 12

FLAVOR OF THE FRUIT PUREE

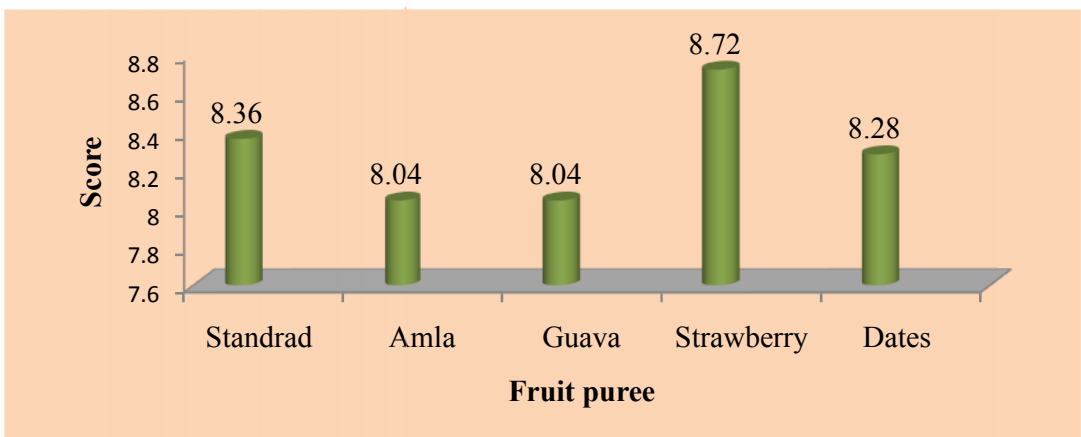

FIGURE 13

TEXTURE OF THE FRUIT PUREE

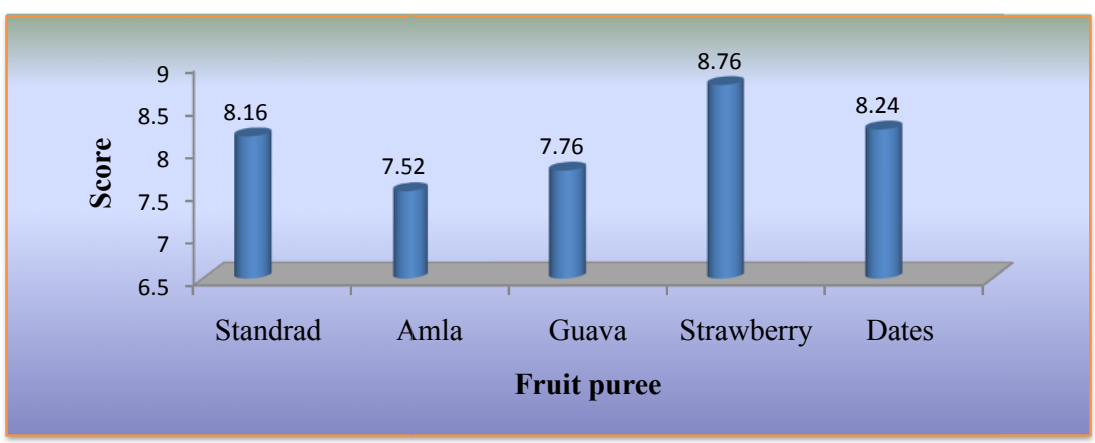

FIGURE 14

OVERALL ACCEPTABILITY OF THE FRUIT PUREE

It is observed from the above table that the strawberry puree was accepted with highest scores for all attributes of sensory evaluation when compared with the standard. This was followed by the dates puree which is in comparison with the standard puree for all parametes of sensory evaluation. Amla and guava puree has lesser scores when compared with the standard puree and the scores were in the range between 7 to 8 i.e. like very much to moderately.

It was observed that no significant difference between appearance and taste of the fruit puree when compared with the standard. Colour and texture of fruit puree was significant at 5% ($p<0.05$) level when compared with the standard. Flavor and overall acceptability of the fruit puree was significant at 1% ($p<0.01$) level when compared with standard. Statistical analysis of the fruit puree presents that the taste was well comparable with the standard with no significant difference. Hence can be included in the daily food as the standard puree.

II. c. Food action rating scale of the vegetable puree

The food action rating scale of the vegetable puree as expressed by the panelist is presented in Table V.

TABLE V

FOOD ACTION RATING SCALE OF VEGETABLE PUREE

Rating	Standard	Carrot puree	Chilli puree	Pumpkin puree	Beetroot puree
I would eat this every opportunity I had	6	4	1	4	2
I would eat this very often	7	2	4	2	5
I would frequently eat this	2	2	3	2	7
I like this and would eat it now and then	1	4	2	4	4
I would eat this if available but would not go out of my way	2	3	2	3	1
I don't like it would eat it on an occasion	0	1	1	1	1
I would hardly ever eat this	1	1	1	1	2
I would eat this only if there were no other food choices	0	1	4	1	0
I would eat this only if were forced to	6	7	7	7	3

In food action rating scale nine statements were used which would best express the opinion of the panelists regarding the food product. "I would eat this every opportunity I

had" scored highest with 6 for standard followed by 4 for carrot puree and pumpkin puree, 2 for beetroot puree and chilli puree. The statement "I would eat this very often" scored 7 for standard followed by 5 for beetroot puree, 4 for chilli puree, 2 for carrot puree and pumpkin puree . "I would frequently eat this" scored 7 for beetroot puree followed by 3 for chilli puree, 2 for standard, carrot puree and pumpkin puree. "I like this and would eat it now and then" scored highest with 4 for carrot puree, pumpkin puree and beetroot puree followed by 2 for chilli puree and 1 for standard. "I would eat this if available but would not go out of my way" scored highest with 3 for carrot puree and pumpkin puree followed by 2 for standard and chilli puree and for in beetroot puree. "I don't like it would eat it on an occasion" scores with 1 for carrot puree, chilli puree, pumpkin puree and beetroot puree. "I would hardly ever eat this" scored highest with 2 for beetroot puree followed by 1 for standard, carrot puree, chilli puree and pumpkin puree. "I would eat this only if there were no other food choices" scores highest with 4 for chilli puree followed by 1 for carrot puree and pumpkin puree. "I would eat this only if were forced to" scored highest with 7 for carrot puree, chilli puree and pumpkin puree followed by 6 for standard and 3 for beetroot puree.

The statement "I would eat this only if were forced to" was expressed by 7 members each for carrot, chilli and pumpkin puree. But 4 members expressed that "I would eat this every opportunity I had" for carrot and pumpkin puree. "I would frequently eat this" was expressed by 7 members for beetroot puree showing a liking towards consuming this.

II.d. Food action rating scale of the fruit puree

The food action rating scale of the fruit puree as expressed by the panelist is presented in Table VI.

TABLE VI

FOOD ACTION RATING SCALE OF FRUIT PUREE

Rating	Standard	Amla puree	Guava puree	Strawberry puree	Dates puree
I would eat this every opportunity I had	10	0	3	15	6
I would eat this very often	4	3	4	3	2
I would frequently eat this	2	3	7	2	4
I like this and would eat it now and then	2	2	4	4	3
I would eat this if available but would not go out of my way	1	1	3	0	3
I don't like it would eat it on an occasion	0	2	1	0	1
I would hardly ever eat this	1	1		0	1
I would eat this only if there were no other food choices	2	2	1	0	0
I would eat this only if were forced to	3	11	2	1	6

Fruit puree prepared from standard using tomato and different fruits using amla, guava, strawberry and dates were discussed in terms of food action rating scale. The statement "I would eat this every opportunity I had" scored highest with 15 for strawberry puree followed by 10 for standard, 6 for dates puree and 3 for guava puree. "I would eat this very often" scored 4 for standard and guava puree followed by 3 for amla puree and strawberry puree and 2 for and dates puree. "I would frequently eat this" scored highest with 7 for guava puree, followed by 4 for dates puree, 3 for amla puree, 2 for standard and strawberry puree. "I like this and would eat it now and then" scored 4 for guava puree and strawberry puree followed by 3 for dates puree, 2 for standard and amla puree. "I would eat this if available but would not go out of my way" scored 3 for guava puree and dates puree followed by 1 for standard and amla puree. "I don't like it would eat it on an occasion" scored 2 for amla puree followed by 1 for guava puree and dates puree. "I would hardly ever eat this" scored 1 for standard, amla puree and dates puree. "I would eat this only if there were no other food choices" scored 2 for standard and amla puree followed by 1 for guava puree. "I would eat this only if were forced to" scored highest

with 11 for amla followed by 6 for dates puree, 3 for standard, 2 for guava puree and 1 for strawberry puree.

Eleven panelists revealed the statement “I would eat this only if were forced to” for amla puree which shows that they did not like the product. The statement “I would frequently eat this” was revealed by 7 members for guava puree which shows a positive attitude of eating this puree. Maximum number of 15 members showed a liking towards the strawberry puree revealing the statement “I would eat this every opportunity I had”. Six members equally revealed two extremes of statement i.e. “I would eat this every opportunity I had” and “I would eat this only if were forced to” for dates puree. This shows that dates puree is either accepted or not accepted by the members.

III.. Physical characteristics of vegetable and fruit puree

Rheological properties

Most liquids are non Newtonian in nature i.e. the viscosity is dependent on shear rate (shear thinning or shear thickening). A fluid is shear thinning if the viscosity of the fluid decreases as the shear rate increases

III.a.Rheological properties of vegetable puree

Carrot puree

The variation of viscosity with shear rate at room temperature for carrot puree is presented in Figure 15.

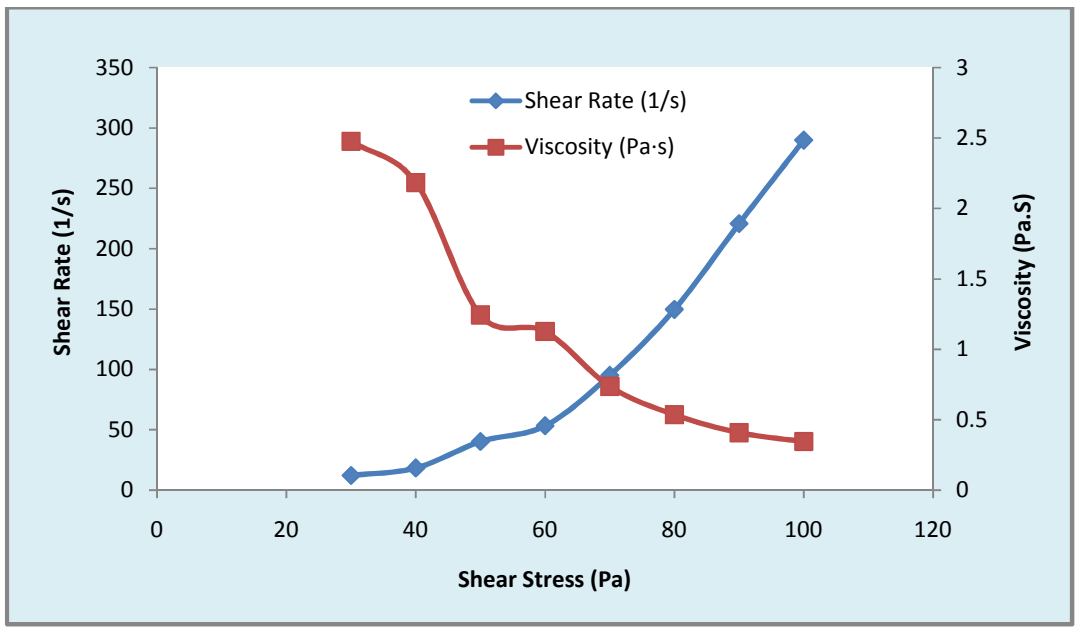

FIGURE 15

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF CARROT PUREE

The range of shear stress for carrot puree was 0 to 120 Pa and the shear rate was 0 to 300 1/s. The maximum viscosity was 2.47 Pa.s at a shear stress of 30.008 Pa at a shear rate of 12 1/s. In this case, the viscosity decreases with shear rate establishing that this sample is shear thinning. The variation of shear rate with shear stress increases. Carrot puree exhibit non Newtonian shear thinning behaviour.

Chilli puree

The variation in shear rate for chilli puree with shear stress is presented in Figure 16.

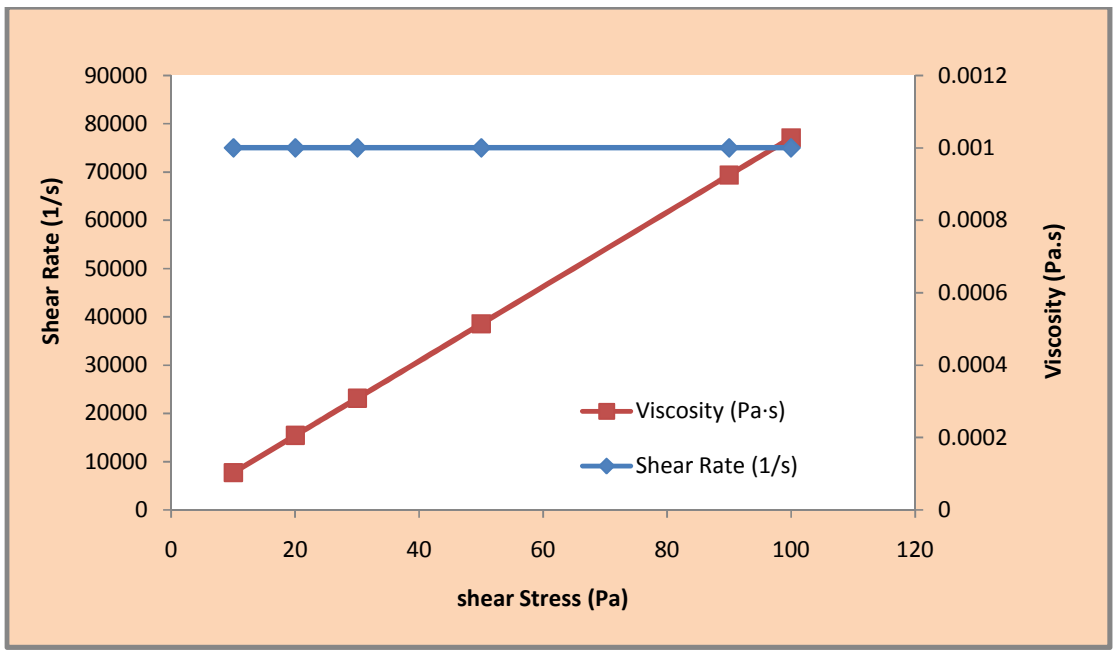

FIGURE 16

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF CHILLI PUREE

The range of shear stress for chilli puree was 0 to 120 Pa and the shear rate was 0 to 90000 1/s. The maximum viscosity was 7724.58 Pa.s at a shear stress of 10.018 Pa and shear rate of 0.001 1/s. The viscosity of chilli puree increases for the same shear rate constant for the same temperature constant for the time interval that varies from 0 seconds to 10 seconds. This shows a different behaviour. When the shear stress varies from 10 to 100 the shear rate remains the same (0.00l) for the same temperature during the time (0 seconds to 10 seconds.) The chilli puree follows non Newtonian shear thickening behaviours.

Pumpkin puree

The variation of viscosity with shear rate is represented in Figure 17 of the pumpkin puree.

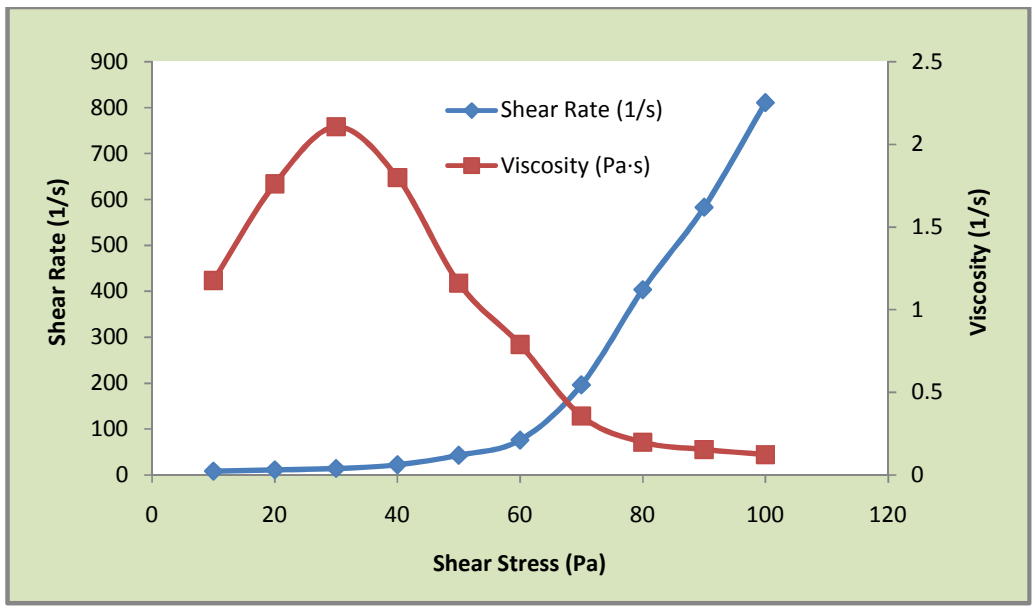

FIGURE 17

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF PUMPKIN PUREE

The range of shear stress for pumpkin puree was 0 to 120 Pa and the shear rate was 0 to 9001/s. The maximum viscosity was 2.10 Pa.s at a shear stress of 30.008 Pa and shear rate of 14 1/s. From the above graph it is inferred that the viscosity decreases with shear rate establishing that pumpkin puree is shear thinning. The variation of shear rate with shear stress increases. Pumpkin puree exhibit non Newtonian shear thinning behaviour.

Beetroot puree

The variation of viscosity with shear rate for beetroot puree is represented in Figure 18.

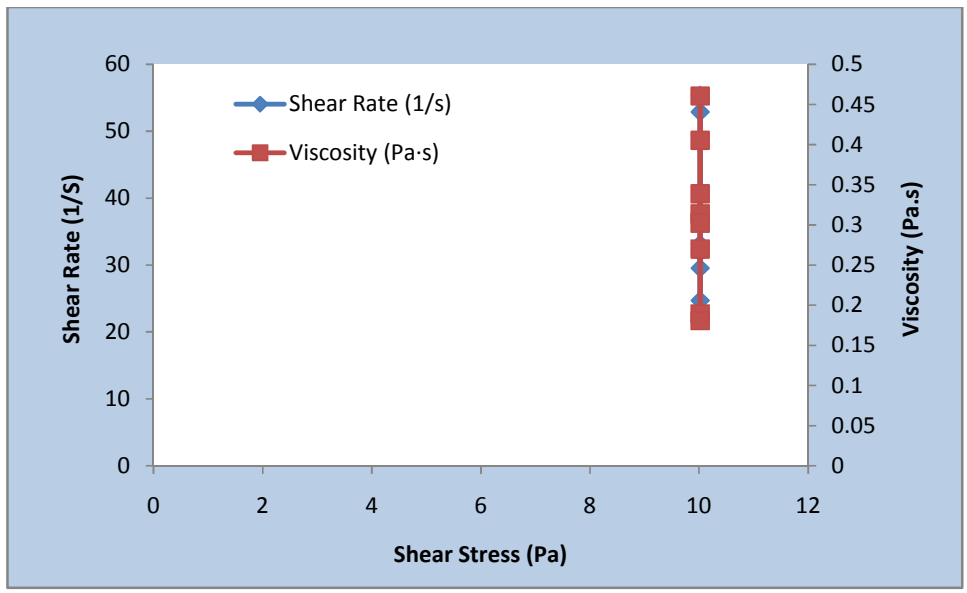

FIGURE 18

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF BEETROOT PUREE

The range of shear stress for beetroot puree was 0 to 12 Pa and the shear rate was 20 to 60 1/s. The maximum viscosity was 0.4606 Pa.s at a shear stress of 10.081 Pa and shear rate of 21.748 1/s. For beetroot puree, the viscosity decreases with shear rate establishing that the sample is shear thinning. For the same shear stress (10.018), shear rate varies from (24.714 to 0.1810) for the same temperature during the time interval from 0 to 564 seconds. Beetroot puree exhibit non Newtonian shear thinning behaviour.

III.b.Rheological properties of fruit puree

Tomato puree

The variation of viscosity for tomato puree with shear rate is represented in Figure 19.

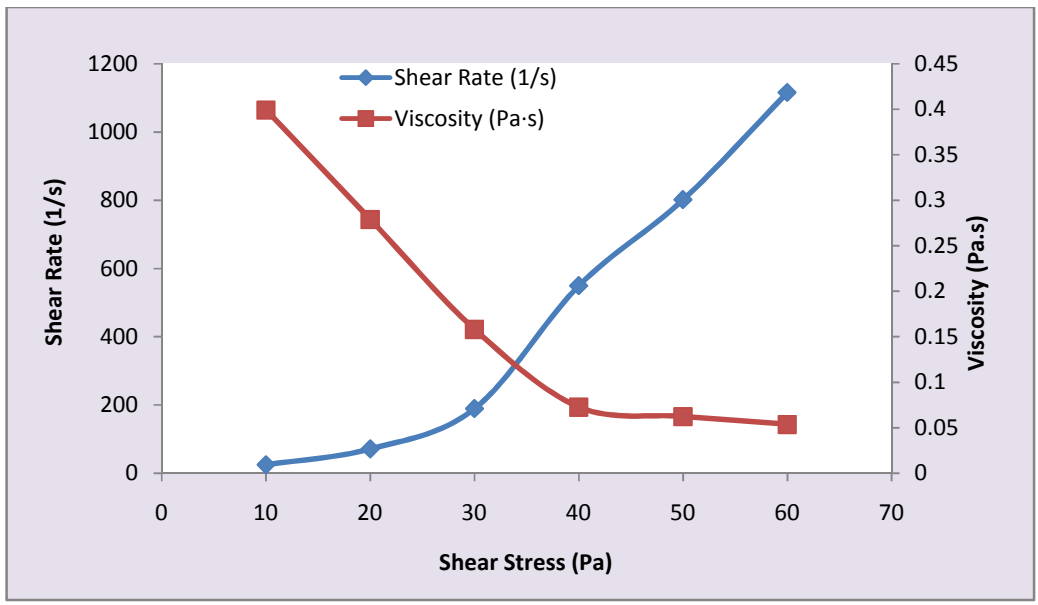

FIGURE 19

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF TOMATO PUREE

The range of shear stress for tomato puree was 0 to 70 Pa and the shear rate was 0 to 1,116 1/s. The maximum viscosity was 0.3990 Pa.s at a shear stress of 10.018 Pa and shear rate of 25.108 1/s. In this case, the viscosity decreases with shear rate establishing that tomato puree is shear thinning. The variation of shear rate with shear stress increases. Tomato puree exhibit non Newtonian shear thinning behaviour.

Amla puree

The variation of viscosity with shear rate for amla puree is represented in Figure 20.

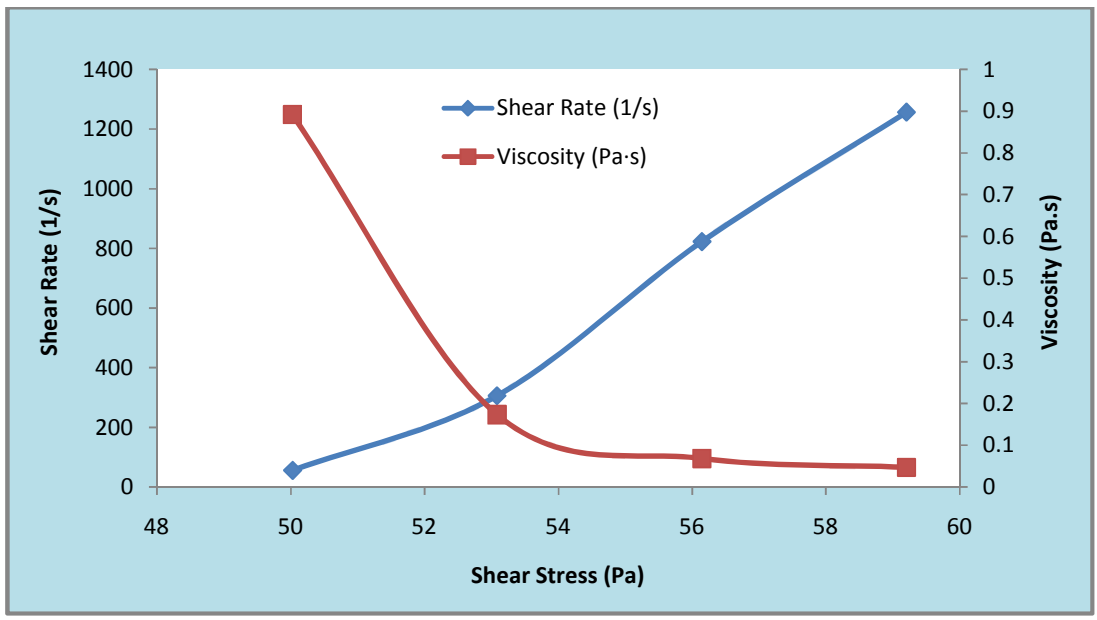

FIGURE 20

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF AMLA PUREE

The range of shear stress for amla puree was 0 to 60 Pa and the shear rate was 0 to 1,258 1/s. The maximum viscosity was 0.8919 Pa.s at a shear stress of 50.025 Pa and shear rate of 56.088 1/s. In this case, the viscosity decreases with shear rate establishing that amla puree is shear thinning. The variation of shear rate with shear stress increases. Amla puree exhibit non Newtonian shear thinning behaviour.

Guava puree

The variation of viscosity with shear rate is represented in Figure 21 for guava puree.

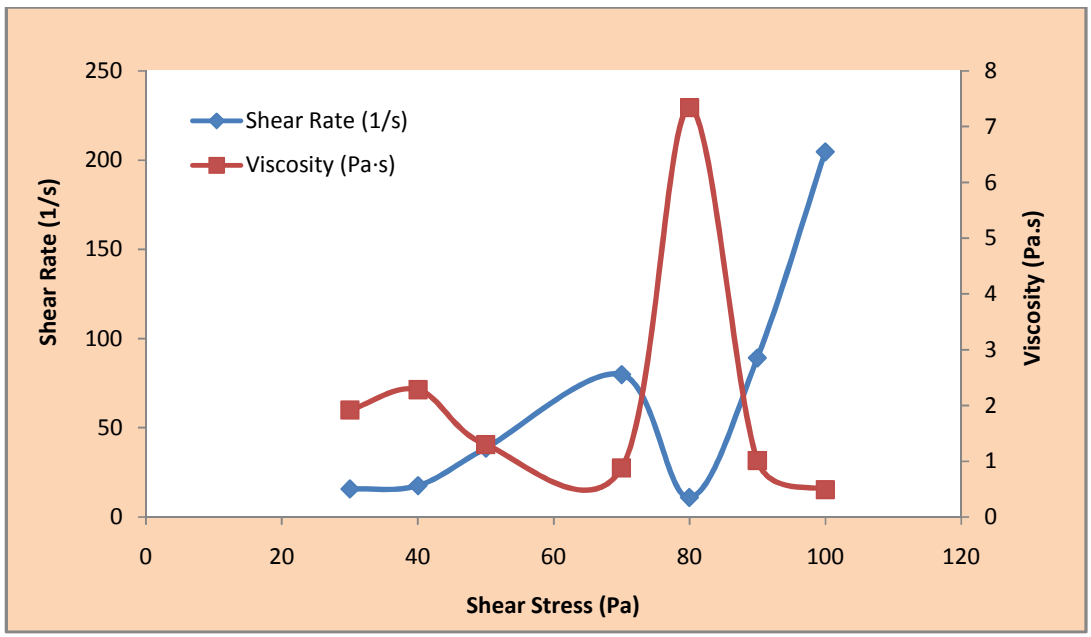

FIGURE 21

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF GUAVA PUREE

The range of shear stress for guava puree was 0 to 120 Pa and the shear rate was 0 to 210 1/s. The maximum viscosity was 2.2834 Pa.s at a shear stress of 40.007 Pa and shear rate of 17.52l 1/s. In this case, the viscosity decreases with shear rate establishing that guava puree is shear thinning. The variation of shear rate with shear stress increases. Guava puree exhibit non Newtonian shear thinning behaviour.

Strawberry puree

The variation of viscosity with shear rate is represented in Figure 22 for the strawberry puree.

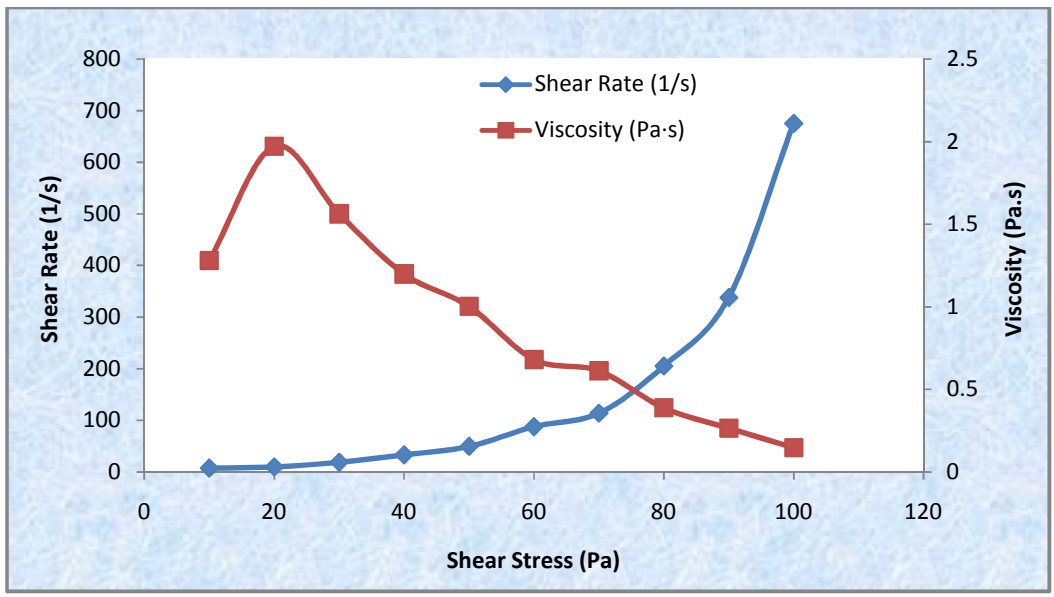

FIGURE 22

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF STRAWBERRY PUREE

The range of shear stress for strawberry puree was 0 to 100 Pa and the shear rate was 0 to 700 1/s. The maximum viscosity was 1.9714 Pa.s at a shear stress of 20.017 Pa and shear rate of 10.153 1/s. In this case, the viscosity decreases with shear rate establishing that this sample in shear thinning. The variation of shear rate with shear stress increases for strawberry puree. Strawberry puree exhibit non Newtonian shear thinning behaviour.

Dates puree

The variation of viscosity with shear rate is represented in Figure 23 for the dates puree.

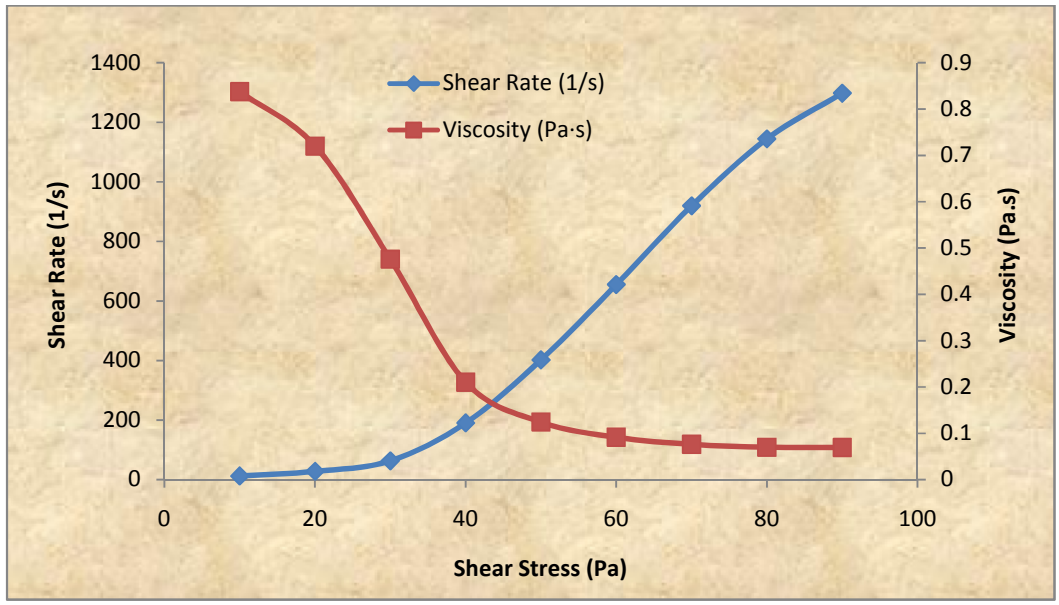

FIGURE 23

SHEAR STRESS, SHEAR RATE AND VISCOSITY OF DATES PUREE

The range of shear stress for dates puree was 0 to 100 Pa and the shear rate was 0 to1,300 1/s. The maximum viscosity was 0.8374 Pa.s at a shear stress of 10.018 Pa and shear rate of 11.964 1/s. In this case, the viscosity decreases with shear rate establishing that this sample is shear thinning. The variation of shear rate with shear stress increases for dates puree. Dates puree exhibit non Newtonian shear thinning behaviour.

Overall rheological properties of the vegetable and fruit puree is presented in Table VII.

TABLE VII

OVERALL RHEOLOGICAL PROPERTIES OF THE VEGETABLE AND FRUIT PUREE

Puree	Variation of viscosity with shear rate for same temperature with time	Variation of shear rate with shear stress for same temperature with time
Carrot	Decreases	Increases
Chilli	Viscosity increases for the same shear rate constant for the same temperature constant for the time interval varying from 0 seconds to 10 seconds and shows a different behaviour.	When the shear stress varies from (10 to 100) the shear rate remains the same (0.00l) for the same temperature during the time (0 seconds to 10 seconds.)
Pumpkin	Decreases	Increases
Beetroot	Decreases	For the same shear stress (10.018) the shear rate varies from (24.714 to 0.181) for the same temperature during the interval from 0 to 564 seconds
Tomato	Decreases	Increases
Amla	Decreases	Increases
Guava	Decreases	Increases
Strawberry	Decreases	Increases
Dates	Decreases	Increases

III.c. Nutrient content of vegetable puree

Table VIII gives the nutrient content of raw and vegetable puree.

TABLE VIII

NUTRIENT CONTENT OF VEGETABLE PUREE

Nutrients	Carrot		Chilli		Pumpkin		Beetroot	
	Raw*	Puree	Raw*	puree	Raw*	puree	Raw*	puree
Energy (Kcal)	43	39	29	22	25	23	48	40
Protein (g)	0.9	0.6	15.9	14.46	1.4	1.43	1.7	1.09
Phosphorus (mg)	530	480	80	48.46	30	16.66	55	27.58
Iron (mg)	1.03	0.73	4.40	3.02	0.44	0.22	1.19	0.87
Vitamin C (mg)	3.0	1.63	111	26	2.0	0.7	10	4.26
Vitamin A (µg)	1890	1817	175	143.04	50	37.8	0	0.06

* values as per Nutritive value of Indian Foods

The analysis of nutrients revealed that carrot puree contained 39 Kcal of energy; 0.9 g of protein; 480 mg of phosphorus; 0.73 mg of iron; 1.63 mg of vitamin C and 1817 µg of vitamin A. The energy, protein, phosphorus and iron content of raw carrot was found to be 43 kcal; 0.9 g; 530 mg and 1.03 mg respectively. The vitamin C and A was found to be 3 mg and 1890 µg in raw carrot.

Chilli puree contained 22 Kcal of energy; 14.26 g of protein; 48.46 mg of phosphorus; 3.02 mg of iron; 26 mg of vitamin C and 143.04 µg of vitamin A. The energy, protein, phosphorus and iron content of raw chilli was found to be 29 kcal; 15.9 g; 80 mg and 4.40 mg respectively. The vitamin C and A was found to be 111 mg and 175µg in raw chilli.

Pumpkin puree contained 25 Kcal of energy; 1.43 g of protein; 16.66mg of phosphorus; 0.22 mg of iron; 0.7 mg of vitamin C and 37.8 µg of vitamin A. The energy content of raw pumpkin is 25 kcal and has a protein content is 1.4 g, phosphorus is 30 mg and iron is 0.44. The vitamin A and vitamin C of raw pumpkin is 50 µg and 2 mg respectively.

Beetroot puree contained 40 Kcal of energy; 1.7 g of protein; 27.58 mg of phosphorus; 0.87 mg of iron; 4.26 mg of vitamin C and 0.06 µg of vitamin A. The energy,

protein, phosphorus and iron content of raw beetroot was found to be 48 Kcal; 1.7 g; 55mg and 1.19 mg respectively. The raw beetroot had 10 mg of vitamin C.

The results of the nutrient analysis of the vegetable puree showed that there was a loss in nutrients when compared the vegetable puree with raw samples. This may be due to the processing of the vegetable like exposure to heat and boiling method of cooking. Maximum loss of vitamins and minerals is observed because of the boiling method of cooking adopted for the preparation of the puree.

Carotenoids have antioxidant activity, but few are converted by the body into retinol, the active form of vitamin A. Among the 600 carotenoids with pro-vitamin A activity, the most common are α- and β-carotene. These carotenoids are susceptible to degradation (e.g., isomerization and oxidation) during cooking. The total carotenoid and carotenoid isomers in puree increased after the cooking methods. Cooking the vegetable reduces several of the protective factors such as vitamins, minerals, phytochemicals, antioxidants and enzymes and is a main disadvantage. It is beyond doubt that cooking induces significant changes in chemical composition and vitamin content, although it depends on the type of cooking. The greater the heat and the longer the time of exposure, the greater is the nutrient destruction

III.d. Nutrient content of fruit puree

Table IX gives the nutrient content of the raw and fruit puree.

TABLE IX

NUTRIENT CONTENT OF FRUIT PUREE

Nutrients	Tomato		Amla		Guava		Strawberry		Dates	
	Raw*	Puree	Raw*	puree	Raw*	puree	Raw*	puree	Raw*	puree
Energy (Kcal)	20	**23**	58	49	51	43	44	40	317	300
Protein (g)	0.9	0.7	0.5	0.2	0.9	0.5	0.7	0.4	2.5	1.78
Phosphorus (mg)	20	5.31	20	14.81	28	14.07	30	21.73	50	35.08
Iron (mg)	0.64	0.37	120	0.81	0.27	0.18	1.80	0.93	7.30	6.08
Vitamin C (mg)	27	17.3	600	164.6	212	52	52	43.3	3	1.6
Vitamin A (μg)	192	164.07	9	6.45	0	0.02	18	10.89	26	13.67

* values as per Nutritive value of Indian Foods

Tomato puree contained 23 Kcal of energy; 0.9 g of protein; 5.31 mg of phosphorus; 0.37 mg of iron; 17.3 mg of vitamin C and 164.07 µg of vitamin A. The energy, protein, phosphorus and iron content of raw tomato was found to be 20 kcal; 0.9 g; 20 mg and 0.64 mg respectively. The vitamin C and A was found to be 27 mg and 192 µg in raw tomato.

Amla puree had 49 Kcal of energy; 0.2 g of protein; 14.81 mg of phosphorus; 0.37 mg of iron; 164.6 mg of vitamin C and 6.45 µg of vitamin A. The energy protein, phosphorus and iron content of raw amla was found to be 48 kcal; 0.5 g 20 mg and 0.64 mg respectively. The vitamin C and A was found to be 600mg and 9µg in raw amla.

Guava puree had 43 Kcal of energy; 0.5 g of protein; 14.07 mg of phosphorus; 0.18 mg of iron 52 mg of vitamin C and 0.02 µg of vitamin A. The energy, protein, phosphorus and iron content of raw guava was found to be 51 kcal, 0.9 g, 28 mg and 0.27 respectively. The vitamin C was 52 mg in raw guava.

Strawberry puree contained 40 Kcal of energy; 0.4 g of protein; 21.73 mg of phosphorus; 1.80mg of iron; 43.3 mg of vitamin C and 10.89 µg of vitamin A. The energy, protein, phosphorus and iron content of raw strawberry was 44 Kcal; 0.7 g; 30 mg and 1.80 mg respectively. The vitamin C and A was 52 mg and 18µg in raw strawberry.

Dates puree had 300 Kcal of energy; 1.78g of protein; 35.08 mg of phosphorus; 6.08 mg of iron; 1.6 mg of vitamin C and 13.67 µg of vitamin A. The energy, protein, phosphorus and iron content of raw dates was 317 Kcal; 2.5 g; 50 mg and 7.30 mg respectively. The vitamin C and A was 3 mg and 26 µg in raw dates.

The nutrient analysis of the fruit puree on comparing with the raw fruit decreased. This loss in nutrients may be attributed to the exposure of fruit to the heat. About 75 % of vitamin C is lost as boiling method is used for the puree preparation. Exposure to heat has contributed to the loss of vitamin C, A and minerals phosphorus and iron.

IV.Physicochemical estimation of vegetable and fruit puree

IV.a. Physicochemical estimation of vegetable puree

Table X gives the physicochemical estimation of the vegetable puree.

TABLE X

PHYSICOCHEMICAL ESTIMATION OF VEGETABLE PUREE

Puree	Moisture (g)	Ash (g)	pH	Soluble solid	Total sugar (g)	Titrable acidity
Carrot	93.2	5.58	4.68	6.2	18.28	1.8
Chilli	81.2	2.96	3.10	10.1	2.6	0.72
Pumpkin	92.8	6.94	4.92	5.2	8	5.22
Beetroot	94.2	6.89	6.09	8.2	12.9	0.9

Physicochemical characteristics of vegetable puree namely, moisture, ash, pH, soluble solid, total sugar and tritrable acidity were analysed in triplicates. The moisture content of the purees varied between 81 to 95 g/100g. The maximum moisture was present in beetroot puree (94.2) and minimum of 81.2 g/100g in chilli puree. The ash content was found to be high in pumpkin puree (9.94 g/100g) followed by beetroot puree (6.89 g/100g), carrot puree (5.58 g/100g) and chilli puree (2.96 g/100g). The lower range of pH of the puree was 3.10 in chilli puree and the highest in beetroot puree with 6.09. The pH states that the puree were in the acidic range where the growth of number of micro organisms is less comparatively. The titrable acidity of pumpkin puree was 5.22, carrot puree was 1.8, beetroot was 0.9 and chilli was 0.72. The total sugar was highest in carrot puree with 18.28 g/100g followed by beetroot puree (8.2 g/100g), pumpkin puree (8 g/100g) and chilli puree (2.6 g/100g).

IV.b. physicochemical estimation of fruit puree

Table XI gives the physicochemical estimation of the fruits puree.

TABLE XI

PHYSICOCHEMICAL ESTIMATION OF FRUIT PUREE

Puree	Moisture (g)	Ash (g)	pH	Soluble solid	Total sugar (g)	Titrable acidity
Tomato	90.6	6.38	4.58	5.8	4.8	10.98
Amla	94.6	2.03	2.94	4.2	2.6	5.58
Guava	88.7	4.42	4.0	7.0	16.7	3.78
Strawberry	91.4	5.26	3.32	19.1	24.3	3.92
Dates	94.3	4.53	4.67	24.3	64.7	1.44

The moisture content of the puree reveals that amla and dates have the maximum moisture content with 94.6 and 94.3 g/100g respectively followed by strawberry puree with 91.4 g/100g, tomato puree with 90.6 g/100g and guava puree with 88.7 g/100g. The ash content ranged between 2 to 6 g/100g in the puree. The pH of the puree revealed that they were in acidic pH with 4.58 in tomato, 2.94 in amla, 4 in guava, 3.32 in strawberry and 4.67 in dates. The titrable acidity shows that the maximum was in tomato puree with 10.98, followed by amla (5.58), strawberry (3.92), guava (3.78) and dates (1.44). The soluble solids was highest in dates (24.3) and lowest in amla (4.2). The soluble solids strawberry was 19.1, guava was 7 and tomato was 5.8. The total sugar was highest in dates with 64.7 g/100g being the sweetest, followed by strawberry (24.3 g/100g), guava (16.7 g/100g), tomato (4.8 g/100g) and amla (2.6 g/100g) which was slightly bitter in taste.

V. Phytochemical analysis of vegetable and fruit puree

V.a Phytochemical analysis of vegetable puree

The phytochemicals present in the vegetable puree is presented in Table XII.

TABLE XII

PHYTOCHEMICAL ANALYSIS OF VEGETABLE PUREE

Phytochemicals	Carrot puree	Chilli puree	Pumpkin puree	Beetroot Puree
Tannins	Absent	Absent	Absent	Present
Terpenoids	Absent	Absent	Absent	Absent
Phenols	Absent	Present	Absent	Present
Flavonoids	Absent	Present	Absent	Present
Saponins	Absent	Present	Present	Present
Quinones	Absent	Present	Absent	Present
Glycosides	Absent	Absent	Absent	Absent
Coumarins	Absent	Present	Absent	Present

Varieties of puree were prepared from different vegetables using carrot, chilli, pumpkin and beetroot. The flavanoids present in Chilli puree are phenols, flavonoids, saponins, quinones and coumarins. The only flavanoid present in pumpkin puree was saponin. The flavanoids present in beetroot puree include tannins, phenols, flavanoids, saponins, quinones and coumarins. The analysis revealed that no flavanoids was present in carrot puree.

V.b. Phytochemical analysis of fruit puree

Table XIII presents the phytochemicals present in the purees prepared with fruits namely tomato, amla, guava, strawberry and dates.

TABLE XIII

PHYTOCHEMICAL ANALYSIS OF FRUIT PUREE

Phytochemicals	Tomato puree	Amla puree	Guava puree	Strawberry puree	Dates puree
Tannins	Absent	Present	Present	Absent	Present
Terpenoids	Absent	Absent	Absent	Absent	Absent
Phenols	Absent	Present	Present	Present	Present
Flavonoids	Present	Present	Absent	Present	Present
Saponins	Present	Absent	Present	Present	Present
Quinones	Present	Present	Present	Present	Present
Glycosides	Absent	Absent	Absent	Absent	Absent
Coumarins	Absent	Present	Present	Present	Present

The analysis of tomato puree revealed that it contained flavonoids, saponins and quinones. The phytochemicals present in amla puree are tannins, phenols, flavonoids, quinines and coumarins. The phytochemicals in guava puree are tannins, phenols, saponins, quinones and coumarins and in strawberry puree include phenols, flavonoids, saponins, quinones and coumarins. The phytochemicals in dates puree was tannins, phenols, flavonoids, saponins, quinones and coumarins.

5. SUMMARY AND CONCLUSION

Vegetables and fruits is a part of the human diet in almost any culture of the world. Diets high in vegetables and fruits are widely recommended for their health promoting properties. Vegetables and fruits 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 fibre

The vegetables and fruits are preserved from age old times in order to consume them during other seasons when they are not available. Many preserved forms are used from ancient times. The preserved forms of vegetables and fruits include pickles, jams, sauce, purees, vathal, vadam, dehydrated salted products, sugar syrupy products, etc. One such method of preserved form of vegetables and fruits includes preparation and preservation of puree, a semisolid food. Puree can be replaced in the recipes during non availability of the vegetables and fruits in a particular season. Hence the study on **"Physicochemical Characteristics of Purees using Seletcted Vegetables and Fruits"** was carried out with the objective of developing and standardising the vegetable and fruit puree and analysing the physical and physicochemical properties.

Vegetables and fruits are rich in vitamins, minerals and other compounds. Based on the literature and availability of vegetables and fruits, in the study area four vegetables and four fruits namely carrot, chilli, pumpkin, beetroot, amla, guava, strawberry and dates rich in nutrients and phytochemicals were selected for the study. Fresh, mature, ripened and intact vegetables and fruits were purchased from the local super market. 100g weighed quantity of fresh fruits and vegetables were taken, soaked and washed under running tap water and removed the skin. This enables to remove the presence of unwanted dust particles, surface soil and micro organisms present in the skin. The peels of the carrot, pumpkin, beetroot and guava were removed using a peeler.

The vegetables and fruits were then cooked in measured volume of water for a stipulated time. Measuring cups were used to measure the amount of water used. A digital timer which has seconds unit was used to record the time taken for cooking the puree. The rise in temperature and the final temperature (in degree Celsius) was measured using a thermometer and recorded. The vegetables and fruits were cooked by closing the lid. So

the loss of nutrients through evaporation was minimised. The amount of water used the time and temperature taken for cooking each of the vegetable and fruit was standardized after repeated trials. Once the vegetables and fruits were cooked thoroughly they were allowed to cool at room temperature. After cooling, the vegetables and fruits were made into a smooth paste using a blender. The smoothness with no lumps was confirmed by passing the puree through a strainer. To the paste, salt, sugar and spices were added in weighed quantities as per the procedure after repeated trials. The procedure followed for the preparation of the puree.

The standardised vegetable and fruit puree were subjected to sensory evaluation. Twenty five semi trained panellists doing post graduation and research in either Food Science and Nutrition and Food Service Management and Dietetics of Avinashilingam Institute for Home Science and Higher education for Women, Coimbatore were selected for conducting the sensory evaluation. Sensory evaluation was carried out using 9 point hedonic scale and Food Action Rating Scale. The 9 point Hedonic scale has scores form extremely liked to extremely disliked with corresponding scores 9 to 1. The Food Action Rating Scale contains nine statements that best represent the attitude of the panelists towards the product.

Physical, physicochemical and phytochemical analysis was carried out for the all vegetable and fruit puree. The physical and physicochemical characteristics analyzed include ash, moisture, energy, protein, phosphorus, iron, vitamin C, vitamin A, pH, soluble solids, total sugar, titrable acidity and rheological property. The phytochemicals analyzed include tannins, terpenoids, phenols, flavonoids, saponins, quinones, glycosides and coumarins.

The data obtained was consolidated and tabulated in which mean and standard deviation were computed. One way ANOVA was used to calculate the significance. The study was approved by the Institutional Human Ethics Committee of Avinashilingam University and the approval number was AUW/IHEC/FSN-16-17/XMT-04.

\The salient findings of the study are summarised below:

- It took 10 minutes and 45 seconds to cook the carrot puree, with 300 ml of water and cooking temperature was 91°C. Chilli puree took a very short time of 8 minutes and 50 seconds to cook when compared with other vegetables with 200 ml of water and cooking temperature was 89°C. Pumpkin puree took 10 minutes and 48 seconds for cooking with water 150ml and a temperature of 89°C. The cooking time take for beetroot puree was very long with 11 minutes, water was 250 ml and cooking temperature was 92°C. This may be due to the thick flesh present in beetroot.
- The fruits namely tomato, amla and dates consumed 300 ml of water to cook the fruit completely whereas guava took 250 ml and strawberry took the least amount of water 30 ml to cook the fruit completely. The cooking time was 10 minutes and 33 seconds which was highest for the dates as the fleshy part was more in dates compared with other fruits. This was followed by tomato with 10 minutes and 29 seconds. All other fruits namely guava took 9 minutes and 30 seconds followed by amla with 8 minutes and 30 seconds, strawberry with 6 minutes and 20 seconds. It was observed that the cooking time was less than 10 minutes for the fruits guava, amla and strawberry. This may be due to more amount of water content in the fruits. Strawberry cooked at a temperature of 75° C which was the minimum temperature taken when compared with other fruits. Tomato cooked at 90° C followed by amla with 92° C, guava with 93°C and dates with 94° C. Dates took the highest temperature to get cooked.
- Vegetable puree prepared from standard using tomato and different vegetables using carrot, chilli, pumpkin and beetroot were discussed in terms of appearance, colour, taste, flavor, texture and overall acceptability. The mean scores for appearance was highest with 8.32 in beetroot puree followed by 8.2 in carrot puree, 8.04 in pumpkin puree and 7.88 in chilli puree. The mean scores for colour was highest with 8.20 in carrot puree and beetroot puree, followed by 8.08 in chilli puree and 7.68 in pumpkin puree. The mean scores for taste was highest with 7.96 in pumpkin puree followed by 7.84 in beetroot puree, 7.68 in carrot puree and 7.6 chilli puree. The mean score for flavor was highest with 7.92 in chilli puree followed by 7.76 in carrot puree and pumpkin puree and 7.64 in beetroot puree. The mean scores for texture was highest with 7.92 in beetroot puree followed by 7.72 in pumpkin puree, 7.68 in carrot puree and 7.44 in chilli puree. The mean

scores for over all acceptability was highest with 8.08 in carrot puree followed by 8.00 in beetroot puree, 7.96 in chilli puree and 7.28 in pumpkin puree. It was observed that there was no significant difference in appearance and colour of the vegetable puree when compared with the standard. The taste and texture of the vegetable puree was significant at 1% ($p<0.01$) level when compared with standard. Flavor of the vegetable puree was significant at 5% ($p<0.05$) level when compared with standard. Statistical analysis revealed there was no significant difference in overall acceptability when compared with the standard. These results reveal that the puree developed with vegetables can be well accepted in means of taste and overall acceptability and hence can be consumed as standard..

- The mean scores for appearance was highest with 8.6 in strawberry puree followed by 8.2 in dates puree, 7.96 in amla puree and 7.88 in guava puree. The mean scores for colour was highest with 8.72 strawberry puree followed by 8.08 in dates puree, 7.8 in guava puree and 7.68 in amla puree. The mean scores for taste was highest with 8.64 in strawberry puree followed by 8.16 in dates puree, 7.64 in guava puree and 7.48 in amla puree. The mean scores for flavor was highest with 8.56 in strawberry puree followed by 8.36 in dates puree, 7.92 in guava puree and 7.6 in amla puree. The mean score for texture was highest with 8.72 in strawberry puree followed by 8.28 in dates puree, 8.04 in amla puree and guava puree. The mean scores for overall acceptability was highest with 8.76 in strawberry puree followed by 8.24 in dates puree, 7.76 in guava puree and 7.52 in amla puree. It was observed that no significant difference between appearance and taste of the fruit puree when compared with the standard. Colour and texture of fruit puree was significant at 5% ($p<0.05$) level when compared with the standard. Flavor and overall acceptability of the fruit puree was significant at 1% ($p<0.01$) level when compared with standard. Statistical analysis of the fruit puree presents that the taste was well comparable with the standard with no significant difference. Hence can be included in the daily food as the standard puree.

- In food action rating scale the statement “I would eat this every opportunity I had” scored highest with 6 for standard followed by 4 for carrot puree and pumpkin puree, 2 for beetroot puree and chilli puree. The statement “I would eat this very often” scored 7 for standard followed by 5 for beetroot puree, 4 for chilli puree, 2 for carrot puree and pumpkin puree . “I would frequently eat this” scored 7 for beetroot puree followed by 3 for chilli puree, 2 for standard, carrot puree and

pumpkin puree. “I like this and would eat it now and then” scored highest with 4for carrot puree, pumpkin puree and beetroot puree followed by 2 for chilli puree and 1 for standard. “I would eat this if available but would not go out of my way” scored highest with 3 for carrot puree and pumpkin puree followed by 2 for standard and chilli puree and for in beetroot puree. “I don’t like it would eat it on an occasion” scores with 1 for carrot puree, chilli puree, pumpkin puree and beetroot puree. “I would hardly ever eat this” scored highest with 2 for beetroot puree followed by 1 for standard, carrot puree, chilli puree and pumpkin puree. “I would eat this only if there were no other food choices” scores highest with 4 for chilli puree followed by 1 for carrot puree and pumpkin puree. “I would eat this only if were forced to” scored highest with 7 for carrot puree, chilli puree and pumpkin puree followed by 6 for standard and 3 for beetroot puree.

- The statement “I would eat this only if were forced to” was expressed by 7 members each for carrot, chilli and pumpkin puree. But 4 members expressed that “I would eat this every opportunity I had” for carrot and pumpkin puree. “I would frequently eat this” was expressed by 7 members for beetroot puree showing a liking towards consuming this.
- Fruit puree prepared from standard using tomato and different fruits using amla, guava, strawberry and dates were discussed in terms of food action rating scale. The statement “I would eat this every opportunity I had” scored highest with 15 for strawberry puree followed by 10 for standard, 6 for dates puree and 3 for guava puree. “I would eat this very often” scored 4 for standard and guava puree followed by 3 for amla puree and strawberry puree and 2 for and dates puree. “I would frequently eat this” scored highest with 7 for guava puree, followed by 4 for dates puree, 3 for amla puree, 2 for standard and strawberry puree. “I like this and would eat it now and then” scored 4 for guava puree and strawberry puree followed by 3 for dates puree, 2 for standard and amla puree. “I would eat this if available but would not go out of my way” scored 3 for guava puree and dates puree followed by 1 for standard and amla puree. “I don’t like it would eat it on an occasion” scored 2 for amla puree followed by 1 for guava puree and dates puree. “I would hardly ever eat this” scored 1 for standard, amla puree and dates puree. “I would eat this only if there were no other food choices” scored 2 for standard and amla puree followed by 1 for guava puree. “I would eat this only if were forced to”

scored highest with 11 for amla followed by 6 for dates puree, 3 for standard, 2 for guava puree and 1 for strawberry puree.

- Eleven panelists revealed the statement "I would eat this only if were forced to" for amla puree which shows that they did not like the product. The statement "I would frequently eat this" was revealed by 7 members for guava puree which shows a positive attitude of eating this puree. Maximum number of 15 members showed a liking towards the strawberry puree revealing the statement "I would eat this every opportunity I had". Six members equally revealed two extremes of statement i.e. "I would eat this every opportunity I had" and "I would eat this only if were forced to" for dates puree. This shows that dates puree is either accepted or not accepted by the members.
- The range of shear stress for carrot puree was 0 to 120 Pa and the shear rate was 0 to 300 1/s. The maximum viscosity was 2.47 Pa.s at a shear stress of 30.008 pa and shear rate of 12 1/s. In this case the viscosity decreases with shear rate establishing that this sample is shear thinning. The variation of shear rate with shear stress increases. Carrot puree exhibit non Newtonian shear thinning behaviour. The range of shear stress for chilli puree was 0 to 120 Pa and the shear rate was 0 to 90000 1/s. The maximum viscosity was 7724.58 Pa.s at a shear stress of 10.018 Pa and shear rate of 0.0011/s. The viscosity of chilli puree increases for the same shear rate constant for the same temperature constant for the time interval varies from 0 seconds to 10 seconds. This shows a different behaviour. When the shear stress varies from 10 to 100 the shear rate remains the same (0.00l) for the same temperature during the time (0 seconds to 10 seconds.) The chilli puree follows non Newtonian shear thickening. The range of shear stress for pumpkin puree was 0 to 120 Pa and the shear rate was 0 to 9001/s. The maximum viscosity was 2.10 Pa.s at a shear stress of 30.008 Pa and shear rate of 141/s. From the above graph it is inferred that the viscosity decreases with shear rate establishing that pumpkin puree is shear thinning. The variation of shear rate with shear stress increases. Pumpkin puree exhibit non Newtonian shear thinning behaviour. The range of shear stress for beetroot puree was 0 to 12 Pa and the shear rate was 20 to 60 1/s. The maximum viscosity was 0.4606 Pa.s at a shear stress of 10.081 Pa and shear rate of 21.748 1/s. For beetroot puree, the viscosity decreases with shear rate establishing that the sample is shear thinning. For the same shear stress (10.018), shear rate varies from (24.714 to 0.1810) for the same temperature during the

interval from 0 to 564 seconds. Beetroot puree exhibit non Newtonian shear thinning behaviour.

- The range of shear stress for tomato puree was 0 to 70 Pa and the shear rate was 0 to 1,116 1/s. The maximum viscosity was 0.3990 Pa.s at a shear stress of 10.018 Pa and shear rate of 25.108 1/s. In this case the viscosity decreases with shear rate establishing that tomato puree is shear thinning. The variation of shear rate with shear stress increases. Tomato puree exhibit non Newtonian shear thinning behaviour. The range of shear stress for amla puree was 0 to 60 Pa and the shear rate was 0 to 1,258 1/s. The maximum viscosity was 0.8919 (Pa.s) at a shear stress of 50.025 Pa and shear rate of 56.088 1/s. In this case the viscosity decreases with shear rate establishing that amla puree is shear thinning. The variation of shear rate with shear stress increases. Amla puree exhibit non Newtonian shear thinning behaviour. The range of shear stress for guava puree was 0 to 120 Pa and the shear rate was 0 to 210 1/s. The maximum viscosity was 2.2834 Pa.s at a shear stress of 40.007 Pa and shear rate of 17.52l 1/s. In this case the viscosity decreases with shear rate establishing that guava puree is shear thinning. The variation of shear rate with shear stress increases. Guava puree exhibit non Newtonian shear thinning behaviour. The range of shear stress for strawberry puree was 0 to 100 Pa and the shear rate was 0 to 700 1/s. The maximum viscosity was 1.9714 Pa.s at a shear stress of 20.017 Pa and shear rate of 10.153 1/s. In this case the viscosity decreases with shear rate establishing that this sample in shear thinning. The variation of shear rate with shear stress increases for strawberry puree. Strawberry puree exhibit non Newtonian shear thinning behaviour. The range of shear stress for dates puree was 0 to 100 Pa and the shear rate was 0 to1.300 1/s. The maximum viscosity was 0.8374 Pa.s at a shear stress of 10.018 Pa and shear rate of 11.964 1/s. In this case, the viscosity decreases with shear rate establishing that this sample is shear thinning. The variation of shear rate with shear stress increases for dates puree. Dates puree exhibit non Newtonian shear thinning behaviour.
- The analysis of nutrients revealed that carrot puree contained 39 Kcal of energy; 0.9 g of protein; 480 mg of phosphorus; 0.73 mg of iron; 1.63 mg of vitamin C and 1817 µg of vitamin A. The energy, protein, phosphorus and iron content of raw carrot was found to be 43 kcal; 0.9 g; 530 mg and 1.03 mg respectively. The vitamin C and A was found to be 3 mg and 1890 µg in raw carrot. Chilli puree contained 22 Kcal of energy; 14.26 g of protein; 48.46 mg of phosphorus; 3.02 mg

of iron; 26 mg of vitamin C and 143.04 µg of vitamin A. The energy, protein, phosphorus and iron content of raw chilli was found to be 29 kcal; 15.9 g; 80 mg and 4.40 mg respectively. The vitamin C and A was found to be 111 mg and 175µg in raw chilli. Pumpkin puree contained 23 Kcal of energy; 1.43 g of protein; 16.66mg of phosphorus; 0.22 mg of iron; 0.7 mg of vitamin C and 37.8 µg of vitamin A. The energy content of raw pumpkin is 25 kcal and has a protein content is 1.4 g, phosphorus is 30 mg and iron is 0.44. The vitamin A and vitamin C of raw pumpkin is 50 µg and 2 mg respectively. Beetroot puree contained 40 Kcal of energy; 1.7 g of protein; 27.58 mg of phosphorus; 0.87 mg of iron; 4.26 mg of vitamin C and 0.06 µg of vitamin A. The energy, protein, phosphorus and iron content of raw beetroot was found to be 48 Kcal; 1.7 g; 55mg and 1.19 mg respectively. The raw beetroot had 10 mg of vitamin C.

- Tomato puree contained 23 Kcal of energy; 0.9 g of protein; 5.31 mg of phosphorus; 0.37 mg of iron; 17.3 mg of vitamin C and 164.07 µg of vitamin A. The energy, protein, phosphorus and iron content of raw tomato was found to be 20 kcal; 0.9 g; 20 mg and 0.64 mg respectively. The vitamin C and A was found to be 27 mg and 192 µg in raw tomato. Amla puree had 49 Kcal of energy; 0.2 g of protein; 14.81 mg of phosphorus; 0.37 mg of iron; 164.6 mg of vitamin C and 6.45 µg of vitamin A. The energy protein, phosphorus and iron content of raw amla was found to be 48 kcal; 0.5 g 20 mg and 0.64 mg respectively. The vitamin C and A was found to be 600mg and 9µg in raw amla. Guava puree had 43 Kcal of energy; 0.5 g of protein; 14.07 mg of phosphorus; 0.18 mg of iron 52 mg of vitamin C and 0.02 µg of vitamin A. The energy, protein, phosphorus and iron content of raw guava was found to be 51 kcal, 0.9 g, 28 mg and 0.27 respectively. The vitamin C was 52 mg in raw guava. Strawberry puree contained 40Kcal of energy; 0.4 g of protein; 21.73 mg of phosphorus; 1.80mg of iron; 43.3 mg of vitamin C and 10.89 µg of vitamin A. The energy, protein, phosphorus and iron content of raw strawberry was 44 Kcal; 0.7 g; 30 mg and 1.80 mg respectively. The vitamin C and A was 52 mg and 18µg in raw strawberry. Dates puree had 300 Kcal of energy; 1.78g of protein; 35.08 mg of phosphorus; 6.08 mg of iron; 1.6 mg of vitamin C and 13.67 µg of vitamin A. The energy, protein, phosphorus and iron content of raw dates was 317 Kcal; 2.5 g; 50 mg and 7.30 mg respectively. The vitamin C and A was 3 mg and 26 µg in raw dates.

- Physicochemical characteristics of vegetable puree namely, moisture, ash, pH, soluble solid, total sugar and tritrable acidity were analysed in triplicates. The moisture content of the purees varied between 81 to 95 g/100g. The maximum moisture was present in beetroot puree (94.2) and minimum of 81.2 g/100g in chilli puree. The ash content was found to be high in pumpkin puree (9.94 g/100g) followed by beetroot puree (6.89 g/100g), carrot puree (5.58 g/100g) and chilli puree (2.96 g/100g). The lower range of pH of the puree was 3.10 in chilli puree and the highest in beetroot puree with 6.09. The pH states that the puree were in the acidic range where the growth of number of micro organisms is less comparatively. The titrable acidity of pumpkin puree was 5.22, carrot puree was 1.8, beetroot was 0.9 and chilli was 0.72. The total sugar was highest in carrot puree with 18.28 g/100g followed by beetroot puree (8.2 g/100g), pumpkin puree (8 g/100g) and chilli puree (2.6 g/100g).
- The moisture content of the puree reveals that amla and dates have the maximum moisture content with 94.6 and 94.3 g/100g respectively followed by strawberry puree with 91.4 g/100g, tomato puree with 90.6 g/100g and guava puree with 88.7 g/100g. The ash content ranged between 2 to 6 g/100g in the puree. The pH of the puree revealed that they were in acidic pH with 4.58 in tomato, 2.94 in amla, 4 in guava, 3.32 in strawberry and 4.67 in dates. The titrable acidity shows that the maximum was in tomato puree with 10.98, followed by amla (5.58), strawberry (3.92), guava (3.78) and dates (1.44). The soluble solids was highest in dates (24.3) and lowest in amla (4.2). The soluble solids strawberry was 19.1, guava was 7 and tomato was 5.8. The total sugar was highest in dates with 64.7 g/100g being the sweetest, followed by strawberry (24.3 g/100g), guava (16.7 g/100g), tomato (4.8 g/100g) and amla (2.6 g/100g) which was slightly bitter in taste.
- Varieties of puree were prepared from different vegetables using carrot, chilli, pumpkin and beetroot. The flavanoids present in Chilli puree are phenols, flavonoids, saponins, quinones and coumarins. The only flavanoid present in pumpkin puree was saponin. The flavanoids present in beetroot puree include tannins, phenols, flavanoids, saponins, quinones and coumarins. The analysis revealed that no flavanoids was present in carrot puree.
- The analysis of tomato puree revealed that it contained flavonoids, saponins and quinones. The phytochemicals present in amla puree are tannins, phenols, flavonoids, quinines and coumarins. The phytochemicals in guava puree are

tannins, phenols, saponins, quinones and coumarins and in strawberry puree include phenols, flavonoids, saponins, quinones and coumarins. The phytochemicals in dates puree was tannins, phenols, flavonoids, saponins, quinones and coumarins.

The study thus brings out the potentials of vegetable and fruit puree in terms of physical, physicochemical and phytochemical properties. Vegetable and fruit puree can be used in the daily dietaries for children adding a variety to the diet along with the enriching nutrients. Purees can also be consumed by the elderly who have the problems of dentures. This help them to alleviate their nutritional status to carry out their daily activities with ease and comfort. Hence vegetable and fruit puree a sustainable nutritious food packed with phytochemicals which can be consumed by all age groups at all times in combination with other food.

Recommendations

- Studies can be conducted by preparing purees using other fruits and vegetables.
- Shelf life studies and toxicological studies can be carried out.
- Rheological properties can be studied in depth at varying temperatures, pH and acidity etc.
- Human trials can be carried out, as puree can be best used as infant / baby foods.
- Trials can be conducted to bring out the potentials of anti-diabetic property, anti-hypertensive property, hypocholesterolemic effect and reduce the risks of CVD and cancer.
- Feeding trials can be conducted using dates and carrot puree to combat anaemia and VAD among children.

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APPENDICES

APPENDIX I- PREPARATION OF PUREE

TOMATO PUREE

Ingredients :

Tomatoes - 100g

Salt -2g

Sugar - 1g

Method:

1. Wash tomatoes and rinse off dirt if any. Then mark a plus at the bottom of each tomato to ensure even cooking.
2. Boil water just enough for the tomatoes to immerse. Now slowly add the tomatoes and cook in medium flame for 10 min or until the skin starts to split and peel off.
3. Now remove the tomatoes and put it in cold water so that it is easy to handle. Then peel of the skin, discard the eyes of the tomatoes. Cut the tomatoes into half and discard the seeds.
4. Puree them in a mixer or blender to a smooth paste without adding water. Transfer this puree again to pan add sugar and salt.
5. Allow it to boil in sim until a thick consistency is reached. Allow the puree to cool down completely and store it in airtight container.

CARROT PUREE

Ingredients:

Carrot -100g (pumpkin, amla, guava, dates)

Water-200ml

Method :

1. Wash the carrot and remove the skin.
2. Cut into a small pieces.
3. Cook the carrot about 10to 15minutes.
4. Now let the cool down .
5. Take it in a blender.

CHILLI PUREE

Ingredients:

Green Chillies – 100g

Onion – 15g

Garlic – 8g

Water – 200ml

Sugar – 3g

Salt to taste

Oil – 3ml

Method:

1. Heat 1tsp oil in a pan, add onions, chillies and garlic sauté the for couple of minutes
2. Add in salt, sugar and water, cover and cook this for 15 minutes
3. Now let the mix cool down
4. Take it in a blender puree smoothly.

BEETROOT PUREE

Ingredients :

Beet root -100g

Water -300ml

Garlic-4g

Bay leaves

Salt-2g

Method:

1. Peel the beet root, cut them in quarts.
2. Place them in in a sauce pan .
3. Add the salt, carsh a garlic cloves. Place the crashed garlic and bay leaves into the sauce pan .
4. Pour the malt vinegar and water .Boil until get the beetroot cooked and half of the liquid left.
5. Remove the garlic and bay leaves.
6. Place the beetroot mix the blender jug.Blend it until get consistent puree.

STRAWBERRY PUREE

Ingredients :

Strawberries- 100 g

water -30 ml

sugar -20g

Method:

1. Clean and cut the strawberries.
2. Put the cutted strawberries in a sauce pan
3. Added 3-5 Tbsp of white sugar .
4. Add 30ml or 1/8 cups lime juice or water.
5. Mix the with a spoon to in corporate all the ingredients.
6. Bring to boil for at least 5-10 mins in medium heat.
7. Remove from the heat and let it cool next blender.

APPENDIX II- SCORE CARD

NINE POINT HEDONIC SCALE
(FOR SENSORY EVALUATION OF PUREE)

Name :
Date :
Class:

Puree	Standard	Variation	Score 9	Like extremely
Appearance			8	Like very much
Colour			7	Like moderately
Flavour			6	Like slightly
Texture			5	Neither like nor dislike
Taste			4	Dislike slightly
Overall acceptability			3	Dislike moderately
			2	Dislike very much
			1	Dislike extremely

Comments:

FOOD ACTION SCALE RATING

- Indicate in appropriate box which of nine statements on the following scale best represent your attitude towards the product

Rating	Standard	Product
I would eat this every opportunity I had		
I would eat this very often		
I would frequently eat this		
I like this and would eat it now and then		
I would eat this if available but would not go out of my way		
I don't like it would eat it on an occasion		
I would hardly ever eat this		
I would eat this only if there were no other food choices		
I would eat this only if were forced to		

Signature

APPENDIX III

a.DETERMINATION OF pH

pH is the measurement of H^+ ion activity; it measures active acidity. pH is determined by measuring the electrode potential between glass and reference electrodes; pH meter is standardized using standard pH buffer. Homogenized sample was used for the determination pH.

b.DETERMINATION OF SOLUBLE SOLIDS

Principle

Measurement of the refractive index of the test solution at 20°C, using a refractometer and use of tables correlating refractive index with soluble solids content expressed as sucrose, or direct reading of the soluble solids content on the refractometer.

Apparatus

Refractometer – indicating the refractive index by means of a scale graduated in 0.0001 in order to allow reading to be estimated 0.0002.

Procedure

Preparation of test solution

Thoroughly mix the sample. Press a part of the sample through a gauge folded in four, rejecting the first drops of the liquid and reserving the remainder of the liquid for the determination.

Place a small quantity of the test solution (2-3 drops) on the prism of the refractometer and immediately adjust the movable prism suitably the field of view. Bring the line dividing the light and dark parts of the surface in the field of view to crossing of the threads and read the value of refractive index.

c.ESTIMATION OF TOTAL SUGAR

The presence of sucrose can be detected by determining sugar before and after inversion by copper-reduction method

Reagents

1. **Fehling's solution-A:** Dissolve 69.28g copper sulphate ($CuSO_4.5\ H_2O$) in water, dilute to 1 litre and filter.(Standard Fehling's solution A or 1)
2. **Fehling's solution-B:** Dissolve 346g of Rochelle salt (Potassium Sodium Tartrate, KNa $C_4H_4O_6.4H_2O$) and 100g NaOH in water, make volume to 1 litre.(Standard Fehling's solution B or 2)

3. **Methylene blue indicator (1%):** Dissolve 1g in 100ml water.
4. **45% neutral lead acetate solution:** Dissolve 225g of neutral lead acetate in water and make up to 500ml. It is used as clarifying agent.
5. **22% Potassium oxalate solution:** Dissolve 110g Potassium oxalate ($K_2C_2O_4$. H_2O) in water and make volume to 500ml. This is used for neutralizing excess of lead acetate.
6. **Standard invert sugar:** Weigh 10g of sucrose into 250ml increase in 1 litre flask, add 100ml water and 5ml concentrated HCl for hydrolysis. Allow to stand for 3 days at 20-25$_O$C or 7 days at 15$_o$C for inversion to take place and then make up to volume.

Standardization of standard invert sugar: Pipette 25ml of standard invert solution in to a 100ml volumetric flask; add 50ml water and few drops of Phenolphthalein indicator. Neutralize with 20% NaOH until solution turns pink. Acidify with 1N HCl adding it drop wise until pink color disappears. Make up to 100ml with water (1ml=2.5mg invert sugar).

Standardization of Fehling's solution: Mix 5ml Fehling A + 5ml Fehling B solution in 250ml conical flask. Add 25-50ml water and heat the flask. Add standard invert sugar solution from the burette dropwise till the solution turns brick red. Add few drops of Methylene blue indicator and add drop-wise invert solution, when the blue color disappears, note the titre value of invert solution, repeat the titration and calculate factor for Fehling's solution as under:-

Procedure For Estimation Of Total Sugar

- Follow the method for preparation of deleaded samples from fruits or fruit products as explained under reducing sugars.
- Take 50 ml of the clarified deleaded solution from step 1 into a 250 ml conical flask
- Add 5 g of citric acid and 50 ml of water boil gently for 10 minutes to complete the inversion of sucrose and allow to cool.
- Transfer the inverted solution to a 250 ml volumetric flask and neutralize with 1 N NaOH using phenolphthalein as indicator and make up the volume to 250 ml with water. Place this solution into the burette and use for filtration.

- Pipette 10ml of mixed Fehling's solution (5 ml of Fehling's A and B) and few ml of water into 250 ml conical flask.
- Heat the flask containing Fehling's solution on hot plate and add sample (clarified sugar) solution drop wise from the burette till faintest blue color remains.
- Add 2-3 drops of methylene blue indicator and complete the titration till the colour changes to brick red precipitates.
- Note the titre value and calculate the total as well as non –reducing sugars from the following equations.

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)

Chairman
Dr. S. Ramalingam
Principal, PSG Institute
of Medical Sciences
& Research, Coimbatore

Member Secretary
Dr. P. R. Padma
Professor, Department of
Biochemistry, Biotechnology and
Bioinformatics

Members
Dr. S. Premakumari
Mr. K.Arulmoli (Legal Expert)
Dr. A. Saraswathy
Mrs. V. Mangayarkarasi
Dr. S. Kowsalya
Dr. N.S. Rohini
Dr.Subhashini K. Sripathi
Mrs. S. Radha Devi
Mrs. Judith Justin

3rd February 2017

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

Dear Madam,

Ref: Your proposal No. IHEC/16-17/FSN-04 entitled "Physicochemical characteristics of purees using selected vegetables and fruits" submitted for approval of the IHEC

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/16-17/FSN-04 entitled "Physicochemical characteristics of purees using selected vegetables and fruits" submitted by you. The Approval number for the same is AUW/IHEC/FSN-16-17/XMT-04.

We wish you all the best in your research endeavours.

Regards,
3/2/17
Dr.P.R.Padma
Member Secretary

Institutional Human Ethics Committee