EFFECTS OF COOKING METHODS ON TOTAL PHENOLICS AND ANTIOXIDANT OF COMMON FRUITY VEGETABLES IN BANGLADESH

A Thesis

by

Rakesh Kumar Datta

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Approved as to the Style and Content by

....

Supervisor

Dr. Sheikh Julfikar Hossain
Professor
Biotechnology and Genetic Engineering Discipline
Khulna University, Khulna-9208
Bangladesh.

Chairman of the Examination Committee

KMHossain 03/02/2013
....

Professor Dr. Khondoker Moazzem Hossain
Biotechnology and Genetic Engineering Discipline
Khulna University
Khulna-9208
Bangladesh

JANUARY, 2013

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DECLARATION

This thesis reports the original research work of author, except as otherwise stated. The material presented has not been submitted either in whole or in part for a degree from this or any other university. The findings of the research has not been/will not be published anywhere without the concurrence of the concerned supervisor.

31.01.13

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Rakesh Kumar Datta

Student No: **MS-100725**

Date: 31.01.2013

DEDICATED

TO

MY BELOVED PARENTS

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The Author

ABSTRACT

Most fruity vegetables undergo cooking before consumption. The influence of cooking methods (boiling, microwaving, pressure cooking and autoclaving) with different time duration (2, 5, 10 and 20 minutes) on total phenolics and antioxidant potential of common fruity vegetables were studied. The study showed increased amount of polyphenols in cooked fruity vegetables than uncooked at different time duration. Polyphenol content, DPPH free radical scavenging and reducing power activity were highest at 2 minutes cooking whereas lowest at 20 minutes. However, they were decreased with increasing time duration. In contrast, total antioxidant capacity gradually increased from 2 minutes to 10 minutes cooking and decreased thereafter. Depending on polyphenol content and antioxidant activity, the used four methods were graded as autoclaving > pressure cooking > microwaving > boiling.

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INTRODUCTION

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INTRODUCTION

Food is the most important basic need of human being. Among a range of natural food stuffs, vegetables are the cheapest and most readily available sources of important proteins, vitamins, minerals, essential amino acids, dietary fiber, trace elements, antioxidants and bio-active compounds that can provide desirable health benefits beyond basic nutrition (Lorgeril et al., 1994; Hertog et al., 1995). Phenolic compounds are widely distributed in fruits and vegetables. Epidemiological studies have indicated that regular consumption of fruits and vegetables is associated with reduced risk of cardiovascular diseases, neuro-degenerative diseases and certain cancers (Amin et al., 2006), diabetes, Alzheimer disease, cataracts and age-related functional decline (Temple, 2000; Willett, 1995). Heart disease, cancer and stroke are the top three leading causes of death in the developed countries could be avoided through appropriate dietary modification (Willett, 1995; Doll, 1981). These dangerous diseases are caused mainly by oxidative free radicals.

However, oxygen is a highly reactive atom that is capable of becoming part of potentially damaging molecules commonly called "free radicals." Free radicals are byproducts of the normal reactions within our body or from external sources such as radiation, ozone, smoking, air pollutants and industrial chemicals. They are electrically charged molecules, capable of attacking the healthy cells of the body, causing them to lose their structure and function (Percival, 1998). The most dangerous free radicals are known as reactive oxygen species (ROS) is a term which encompasses all highly reactive oxygen-containing molecules, including free radicals. Biological reactions including the generation of calories, the degradation of lipids, the catecholamine response under stress and inflammatory processes can produce reactive oxygen species (ROS) (Wang et al., 2008). Types of ROS include the hydroxyl radical, the superoxide anion radical, hydrogen peroxide, singlet oxygen, nitric oxide radical, hypochlorite radical and various lipid peroxides. Fortunately, free radical formation is controlled naturally by various beneficial compounds known as antioxidants (Benzie and Strain, 2005).

An antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules (Sies, 1997). Oxidation is a chemical reaction that transfers electrons from a substance to an oxidizing agent and can produce free radicals, which start chain reactions that damage cells. Antioxidants terminate these chain reactions by removing free radical intermediates and inhibit other oxidation reactions by being oxidized themselves. As a result, antioxidants are often reducing agents such as thiols, ascorbic acid or polyphenols (Sies, 1997). Antioxidants are effective against free radicals because they are willing to give up their own electrons to free radicals. When a free radical gains the electron from an antioxidant it no longer needs to attack the cell and the chain reaction of oxidation is broken (Dekkers et al., 1996). After donating an electron an antioxidant becomes a free radical by definition. Antioxidants in this state are not harmful because they have the ability to accommodate the change in electrons without becoming reactive. To protect the cells and organ systems of the body against free radicals humans have evolved a highly sophisticated and complex antioxidant protection system. It involves a variety of components, both endogenous and exogenous in origin, that function interactively and synergistically to neutralize free radicals (Jacob, 1995). In general, the antioxidants can be classified into two mechanistic categories: preventive antioxidants and chain-breaking antioxidants. Preventive antioxidants, such as superoxide dismutase, catalase, peroxidase and transferrin, inhibit formation of reactive oxygen species. Chain-breaking antioxidants are compounds that scavenge oxygen radicals and thereby break radical chain sequences. They include vitamin C, vitamin E, uric acid, bilirubin and polyphenols.

Since, vegetables are the potential source of natural antioxidants; they have phenolic compounds, which affect their appearance, taste, odor and oxidative stability (Walton, 1999). They possess biological properties such as antioxidant, antiapoptosis, anti-aging, anticarcinogen, anti-inflammation, anti-arthrosclerosis, cardiovascular protection, improvement of the endothelial function as well as inhibition of angiogenesis and cell proliferation activity (Han et al., 2007). They are very low in calories and are consumed sometimes in fresh state and also after processing and cooking. A calorie-restricted diet decreases chemically induced tumor incidence and increases life expectancy, reducing oxidative damage and altering rates of cell division and/or apoptosis. This fact not only attenuates the generation of ROS by liver mitochondria but also alters the activities of the electron transport chain (Hwang and Bowen, 2007). Deep-colored vegetables contain high concentrations of numerous redox-active antioxidants, such as polyphenols, carotenoids, tocopherols, glutathione, ascorbic acid and enzymes (Qian et al., 2004). Polyphenols act as reducing agents, hydrogen donators and singlet oxygen quenchers. They contain hydrophilic and lipophilic antioxidant compounds and act together more effectively than singly because they function synergistically and are capable of quenching free radicals in both aqueous and lipid phases (Ohr, 2004; Trombino et al., 2004).

However, most of the fruity vegetables are commonly cooked by simple boiling, microwaving, pressure cooking or autoclaving before consumed. Cooking results inactivation of enzymes, softening of the structure of vegetables and also changes in mechanical properties such as flexibility and strength (Mate et al., 1998). Cooking can affect the activity of antioxidant by releasing the phytochemicals from tissue to extracts. It softens the cell walls and facilities the extraction of carotenoids (Rodriguez-Amaya, 1999). These cooking processes would bring about a number of changes in physical characteristics as well as chemical composition of the vegetables. Domestic cooking can dramatically reduce activities of antioxidant components, as many of these compounds are very sensitive to heat and are soluble in water (Zhang and Hamauzu, 2004). Boiling, which causes overall flavonol losses (Makris and Rossiter, 2001), microwaving (Zhan and Hamauzu, 2004), pressure-cooking, griddling, baking and frying (Young and Jolly, 1990), can profoundly affect both the texture and the nutritional value of vegetables. Absorption of water during boiling can dilute and cause leaching of antioxidant compounds and thus decrease their antioxidant content. A loss of vitamins in vegetables during cooking varies with the cooking treatment suggested that both antioxidant levels and activities of processed vegetables were lower than those of the corresponding fresh samples (Podsedek, 2007).

There is a great amount of literature available concerning levels of antioxidant properties in raw fruit and vegetables (Sun et al., 2007; Gawlik-Dziki, 2008; Roy et al., 2009). However, a few literature regarding the content of antioxidants in vegetables as usually eaten, i.e. after cooking with different time duration. Variation in both cooking treatment and cooking duration may affect the nutritional value of vegetables (Lin and Chang, 2005).

The aim of this study was to investigate the effects of cooking methods (boiling, microwaving, pressure cooking and autoclaving) with different (2, 5, 10, 20 minutes) time duration on total phenolics and antioxidant potentiality of common fruity vegetables in Bangladesh.

OBJECTIVES

The research was conducted to determine

- effects of different cooking methods (boiling, microwave oven, autoclaving and pressure cooking) on total phenolic content of common fruity vegetables in Bangladesh,
- effects of different cooking methods on antioxidant potential of the vegetables,
- effects of different cooking time on phenolic content and antioxidant potential,
- the best way of cooking that retains highest phenolics and antioxidant potential,
- the time duration of cooking that retains highest amount of total phenolics and antioxidant potential of common fruity vegetables.

CHAPTER TWO

LITERATURE REVIEW

CHAPTER TWO
LITERATURE REVIEW

A free radical is a compound with one or more unpaired electrons in its outer orbital (Jesberger and Richardson, 1991). Electrons strongly prefer to go around in twos. So as a result of this lonely unpaired electron, free radicals have a tendency to steal back an electron from neighboring molecules (Sreejayan and Rao, 1997). These neighboring molecules can be any of the foreign bodies or the body's own active cellular component. When free radicals steal an electron from a surrounding compound or molecule, a new free radical is formed in its place. In turn, the newly formed radical then looks to return to its ground state by stealing electrons with antiparallel spins from cellular structures or molecules. Thus the chain reaction continues and can be "thousands of events long". Free radicals can be formed by three ways -

• By homolytic cleavage of covalent bond of normal molecule, with each fragment retaining one of paired electrons.

$$X:Y \longrightarrow X^* + Y^*$$

• By the loss of single electron from normal molecule.

$$X:Y \longrightarrow X + Y$$

• By addition of single electron to normal molecule.

$$X + e \longrightarrow X$$

Free radicals are extremely harmful and can damage important molecules within the body. Free radicals can cause damage to the cell membrane by oxidation thereby making them leaky (Shigenaga et al., 1994). Oxidation of another type of lipid, the low-density-lipoprotein, is considered to play a major role in the development of atherogenesis (the thickening of arterial walls) (Witztum, 1994). Free radicals also cause damage to proteins and genes. Oxidative damage to DNA over time can cause changes to both the structure and function of chromosomes. These changes in the genetic code lead to cancer and other chronic diseases

(Agarwal and Sohal, 1994; Ames et al., 1995; Loft and Poulsen, 1996; Musarrat et al., 1996). Free radicals also interfere with protein functions, leading to irregular and abnormal metabolism (Stadtman and Oliver, 1991). Free radicals also spoil foods and degrade materials such as rubber, gasoline and lubricating (Dexter et al., 1994).

However, to neutralize the free radicals, antioxidant plays an important role. In the late 19th and early 20th century, extensive study was devoted to the uses of antioxidants in important industrial processes, such as the prevention of metal corrosion, the vulcanization of rubber and the polymerization of fuels in the fouling of internal combustion engines (Matill, 1947). Early research on the role of antioxidants in biology focused on their use in preventing the oxidation of unsaturated fats, which is the cause of rancidity (German, 1999). However, it was the identification of vitamins A, C and E as antioxidants that revolutionized the field and led to the realization of the importance of antioxidants in the biochemistry of living organisms (Jacob, 1996; Knight, 1998).

An antioxidant is any substance that retards or prevents deterioration, damage or destruction by oxidation (Dekkers et al., 1996). The human body has an elaborate antioxidant defense system. Antioxidants are manufactured within the body and can also be extracted from the foods such as fruits, vegetables, seeds, nuts, meats, and oils.. The antioxidant can also be defined as "A compound capable of inhibiting oxygen mediated oxidation of diverse substances from simple molecule to polymer and complex bio-systems" (Murthy, 2001).Phenolic and polyphenolic compounds constitute the main class of natural antioxidants present in plants, foods and beverages. Phenols are aromatic compounds with a hydroxyl functional group. Phenolic compounds are well known as radical scavengers, metal chelators, reducing agents, hydrogen donors, and singlet oxygen quenchers (Proestos et al., 2006). The antioxidant activity of phenolics is mainly due to their redox properties, which allow them to act as reducing agents.

2.1 Antioxidant Protection System

Table 01: Antioxidant Protection System (Source: Percival, 1998)

Protection places of antioxidant	Antioxidants
Endogenous Antioxidants	• Bilirubin • Thiols, e.g., glutathione, lipoic acid, N-acetyl cysteine • NADPH and NADH • Ubiquinone (coenzyme Q10) • Uric acid • Enzymes: – copper/zinc and manganese-dependent superoxidedismutase (SOD) – iron-dependent catalase – selenium-dependent glutathione peroxidase
Dietary Antioxidants	• Vitamin C • Vitamin E • Beta carotene and other carotenoids and oxycarotenoids,e.g., lycopene and lutein. • Polyphenols, e.g., flavonoids, flavones, flavonols andproanthocyanidins
Metal Binding Proteins	• Albumin (copper) • Ceruloplasmin (copper) • Metallothionein (copper • Ferritin (iron) • Myoglobin (iron) • Transferrin (iron)

Table 02: Types of antioxidants within the body (Source: Encyclopedia of Human Nutrition, Second Edition, 2005)

Possible Antioxidative Activity	Example
Physical barriers preventing ROS generation or ROS access to important biological sites	Cell membranes
Chemical traps or sinks 'absorb' energy and electrons and quench ROS	Carotenoids, Anthocyanidins
Catalytic systems neutralize or divert ROS	Superoxide dismutase, Catalase, and Glutathione peroxidase
Binding and redox inactivation of metal ions prevent generation of ROS by inhibiting the Haber–Weiss reaction	Ferritin, Caeruloplasmin, Catechins
Sacrificial and chain-breaking antioxidants scavenge and destroy ROS	Ascorbic acid (Vitamin C), Tocopherol (Vitamin E), Uric acid, Glutathione, and Flavonoids

Table 03: Dietary antioxidants and their common sources (Source: Encyclopedia of Human Nutrition, Second Edition, 2005)

Antioxidants	Dietary Sources
Ascorbic acid (vitamin C)	Fruits and vegetables, particularly strawberries, citrus, kiwi, Brussels sprouts, and cauliflower
Tocopherol (vitamin E)	Green leafy vegetables, e.g., spinach, nuts, seeds, especially wheatgerm, vegetable oils, especially sunflower
Carotenoids	Orange/red fruits and vegetables (carrot, tomato, apricot, melon, yam), green leafy vegetables
Flavonoids	Berries, apples, onions, tea, red wine, some herbs (parsley, thyme), citrus fruits, grapes, cherries

2.2 Applications of Antioxidant

Table 04: The applications of antioxidants (Source: Packer and Colman, 1999)

Antioxidant	Strengthens	Helps Prevent	Other	Found In
Lipoic Acid	Memory, energy production, controls adult diabetes	Heart disease, cancer, stroke, cataracts	Recycles all five of the network antioxidants	Potatoes, spinach
Vitamin E	Increases life span, helps clear clogged arteries, protects skin, relieves arthritis	Heart disease, stroke, Alzheimer's, skin, prostate and breast cancer	Need all 4 tocopherols and 4 tocotrienols. "d-alpha" is natural, "dl-alpha" is synthetic	Vegetable oils, nuts, grain, tocotrienols in bran
Vitamin C	Immune system, recycles vitamin E	Cancer, heart disease, scurvy	More than 300 mg per dose is excreted	Red peppers, broccoli, cranberries, citrus
CoQ10	Rejuvenates brain cells	Heart disease, gum disease	Has been used for 20 yrs in Japan to treat and prevent heart disease	Seafood and organ meat
Glutathione	Detoxifies body, strenthens immune system, prolongs life	Prevents bronchitis and pneumonia	Takes 100 mg of lipoic acid for body to make it. It is the cell's primary antioxidant	Fresh fruits and vegetables
Flavonoids	Improve memory and concentration, lowers blood pressure	Blood clots, LDL cholesterol in arteries, reduces inflammation	Boosts effectiveness of vitamin C, found with it in nature	Citrus fruits, apples, onions, red grapes, berries, pine bark
Carotenoids	Converts to Vitamin A if needed, good for eyes and vision	Cancer, lycopene for prostate cancer, lutein for cataracts, heart attack	Give the color to yellow, orange, red, purple and dark green vegetables	The colorful fruits and vegetables: Alpha carotene is orange and in carrots, lutein is the green in spinach, lycopene in red tomatoes.
Selenium	Synergistic effect with vitamin E	Lung, prostate and colon cancer, stroke and heart disease	Trace mineral needed for formation of two antioxidants	Garlic, onion, broccoli, whole grains, red grapes, egg yolks

2.3 Antioxidant defense system

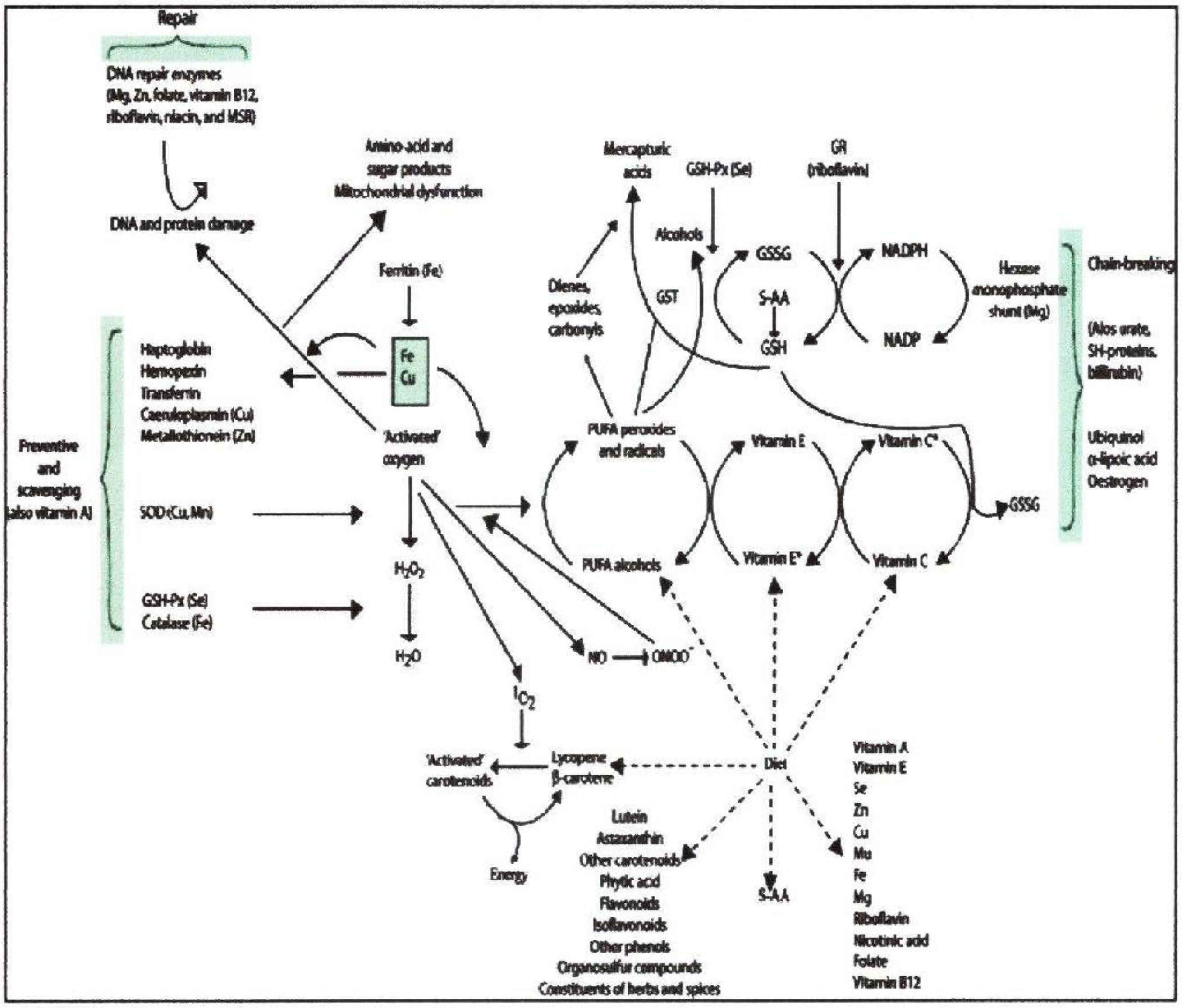

Fig 1: The integrated antioxidant defense system comprises both endogenous and dietary-derived antioxidants.

GR, glutathione reductase; GSH, reduced glutathione; GSH-Px, glutathione peroxidase; GSSG, oxidized glutathione; GST, glutathione-S-transferase; MSR, methionine sulfoxidereductase; NADPH and, NADP, are, respectively, the reduced and oxidized forms of the co-factor nicotinamide adenine dinucleotide phosphate; PUFA, polyunsaturated fatty acid; S-AA, sulfur amino-acids; SH, sulfydryl; SOD, superoxide dismutase.

(Source: Encyclopedia of Human Nutrition, Second Edition, 2005)

2.4 Antioxidant activity of cooked vegetables with different time duration

Plants are good source of natural antioxidants. Various reports described antioxidant property of phytochemicals, mainly contributed by the phenolics. The presence of OH functional group in phenolics helps them to be antioxidants. Fruity vegetables are inevitable in our daily diet. They are rich source of vitamins and essential elements. Consumption of fruity vegetables is a major source of vitamins and micro-nutrients needed for the normal functioning of the body physiology. They serve as a good source of antioxidants apart from nutritive contribution of carbohydrates, proteins and lipids and nutrients which form a major class of vegetable groups that have been called as "natures anti-aging wonders".

Different cooking methods can affect various indicators of antioxidant activity. Total reducing capacity of vegetables can be significantly reduced by processing and thermal treatment. For a large part, this reduction is due to an overall loss via leaching of hydrophilic antioxidants while there is a relative increase in the lipophilic reducing capacity via concentration of non-hydrophilic compounds as a result of almost all thermal treatments. This increase in lipophilic reducing capacity may be due to an increase in the bioavailability of lipophilic antioxidants (Greco et al., 2007). Effect of various cooking methods on antioxidant content and radical scavenging activity of pumpkin was evaluated. Pumpkin (*Cucurbita moschata*) was boiled and stir-fried for 2, 4 and 6 minutes respectively. The free radical scavenging activity exhibited by cooked pumpkins was found to be high (Azizah et al, 2009). The influence of domestic cooking methods on the antioxidant activity, total phenolic and total flavonoid contents of dry beans (DB) and pinto beans (PB) was investigated. Total phenolic and flavonoid contents of raw PB were greater than DB (Akillioglu et al., 2009).

The effects of grilled, boiled and raw eggplant aqueous extract showed cooked samples had greater antioxidant effects than the raw sample indicates that cooking eggplant increases the principal phenolic contents (Braga et al., 2012). Different types of cashew "flesh" underwent different methods of cooking (boiling, steaming, frying and a mixed method) and their bioactive compounds were measured. The artisan cashew fiber had a high level of ascorbic acid, (147.8 mg. /100g), which is an excellent source of vitamin C (Natalia et al., 2011).

The influence of home cooking methods (boiling, microwaving, pressure-cooking, griddling, frying and baking) on the antioxidant activity of vegetables has been evaluated in 20 vegetables, using different antioxidant activity assays. Artichoke was the only vegetable that kept its very high scavenging-lipoperoxyl radical capacity in all the cooking methods. The highest losses of scavenging capacity were observed in cauliflower after boiling and microwaving, pea after boiling and zucchini after boiling and frying. Beetroot, green bean and garlic kept their antioxidant activity after most cooking treatments (Jimenez-Monreal et al., 2007). The effects of three common cooking practices (i.e., boiling, steaming and frying) on the artichoke phenolic compounds pattern, variation of carotenoids, antioxidant capacity and artichoke physical properties after cooking were evaluated. The major phenolic compounds present in the raw sample were 5-O-caffeoylquinic and 1, 5-di-Ocaffeoylquinic acids; after cooking treatments, an increase of the overall caffeoylquinic acids concentration due to the formation of different dicaffeoylquinic acid isomers was observed (Ferracane et al., 2008).

Effects of boiling, steaming and microwaving of broccoli, cauliflower, cabbage and choy-sum (Chinese cabbage) were explored by measuring antioxidant contents of raw and cooked vegetables. For all cooked vegetables, antioxidant content was highest in steamed > boiled > microwaved and decreased with longer cooking time, regardless of method (Wachtel-Galor et al., 2008). Microwaved, baked, fried and raw Potato (*Solanum tuberosum* L.) was observed on carotenoid content, antioxidant activity and phenolic content. The samples microwaved, baked and fried contained higher antioxidant activity and phenolics than the boiled or raw samples (Blessington, 2005). Four sweet potatoes in Egypt were cooked using four different home-cooking methods (boiling, baking, microwaving and deep-frying) indicated that total phenolic contents of ranged from 0.53 to 0.87 mg chlorogenic acid equivalent (mg ChAE)/g dry weight. Deep-frying exhibited the highest increment among the four processing methods (Bellail et al., 2008).

To determine the effects of different cooking times (10 and 15 min) on antioxidant activity (total antioxidant and free radical-scavenging activities) and total phenolic content of four types of *Amaranthus* species locally known as bayam putih (*Amaranthus paniculatus*) (BP), bayam merah (*Amaranthus gangeticus*) (BM), bayam itik (*Amaranthus blitum*) (BI) and bayam panjang (*Amaranthus viridis*) (BPG), were studied. Total antioxidant activity of water-soluble components was in the order of BI > BM >BPG > BP, whereas free radical-scavenging activity was in the order of BI > BPG > BM > BP. The total phenolic contents of BM and BP were significantly higher ($p < 0.05$) than other samples. Antioxidant activities and phenolic contents of all the spinach were in the order of raw > cooking 10 min > cooking 15 min. Cooking up to 15 min may affect losses of antioxidant activity and phenolic content (Amin et al., 2008). Effects of different blanching times on antioxidant content in selected vegetables (carrot, cabbage, and green beans) were evaluated. The 10 min blanching time had the greatest effect on the Vitamin C content in all the vegetables, most especially cabbage. Concentrations of the antioxidant decreased as the blanching time increased, that is, vitamin C concentrations were in the order: Raw > 2min > 5min > 10min. Raw carrot, cabbage and green beans have decreased from their initial concentrations by 13.46%, 32.43% and 10.77% respectively after 10 min blanched (Gimba et al., 2012).

CHAPTER THREE

PLANT PREVIEW

CHAPTER THREE
PLANT PREVIEW

3.1 Sample Name: *Abelmoschus esculentus*

Okra, a member of the hibiscus family, is an annual. It is valued for its edible green seed pods. Originating in Africa, the plant is cultivated in tropical, subtropical and warm temperate regions around the world

3.1.1Scientific classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Malvales
Family: Malvaceae
Genus: *Abelmoschus*
Species: *Abelmoschus esculentus (*L.)
Local Name: Dharos
English Name: Okra

Fig 2: ***Abelmoschus esculentus***

3.1.2 Uses

Okra is a popular health food due to its high fiber, vitamin C and folate content. It is also known for being high in antioxidants and is also often eaten as part of a weight loss diet since it is both fat-free and cholesterol-free. It is also a good source of calcium and potassium. The products of the plant are mucilaginouscan be used as a plasma replacement. The mucilage in okra binds cholesterol and bile acids that are carrying toxins produced by the liver. The cooked leaves can also be used as a powerful soup thickener. Okra is widely used in a thick stew made with vegetables and meat. Greenish-yellow edible okra oil high in unsaturated fats such as oleic acid. It is suitable for use as a biofuel (Mays et al., 1990).

3.2 Sample Name: *Cucurbita mixta*

Cucurbita mixta are a gourd-like squashes of the genus Cucurbita. Like all Cucurbita plants, it is relatively large and grows on vine like stems, producing yellow flowers, orange or yellow squash with many creases running from the stem to the bottom, with shell on the outside and with seeds and pulp on the inside. The fruits vary in shape, color and sizes. It`s seed oil extracted from seeds of pumpkin. Seed oil various from dark yellow to brown in color (Borhade, 2012).

3.2.1 Scientific classification

Kingdom: Plantae
Order: Cucurbitales
Family: Cucurbitaceae
Genus: *Cucurbita*
Species: *Cucurbita mixta (*T.)
Local Name: Misti Kumra
English Name: Pumpkin

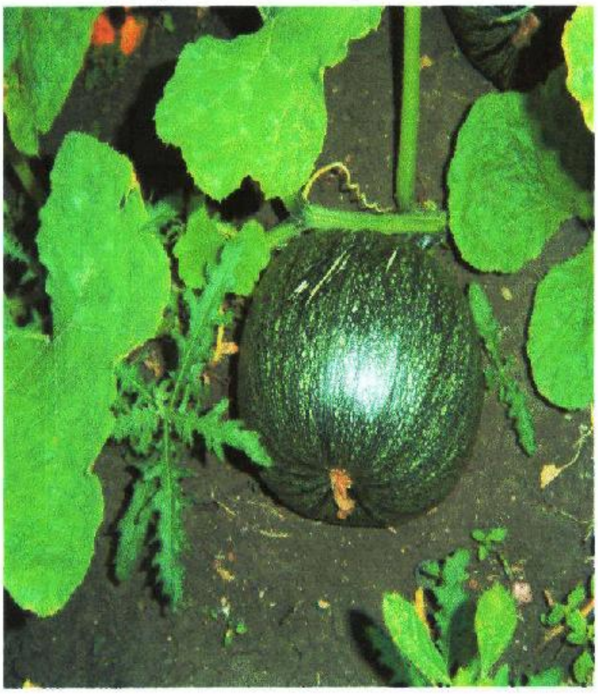

Fig 3: ***Cucurbita mixta***

3.2.2 Uses

Pumpkin fruit has many nutritional components including pumpkin polysaccharides active proteins, essential amino acids, important antioxidants, carotenoids and minerals. Pumpkin seeds are widely distributed in the traditional medicines, has pharmacological activities such as anti-diabetic, antifungal, antibacterial and anti-inflammation activities and antioxidant effect. Pumpkin seed oil is used to prevent the growth and reducing the size of the prostate. It also have some health benefits as retardation of the progression of hypertension, mitigation of hypercholesterolemia and arthritis, reduction of bladder and urethral pressure, alleviation of diabetes by promoting hypoglycemic activity, and lowering levels of gastric, breast, lung and colorectal cancer (Borhade, 2012).

3.3 Sample Name: *Cucumis dipsaceus*

The teasel gourd is in the family of cucurbitaceae mostly prostrate or climbing herbaceous. The leaves are alternate and usually palmately five lobed or divided. The flowers are actinomorphic and nearly always unisexual, extensively cultivated as vegetable crop throughout the country.

3.3.1 Scientific classification

Kingdom: Plantae
Subkingdom: Traceobionta
Superdivision: Spermatophyte
Division: Magnoliophyta
Class: Magnoliopsida
Order: Cucurbitales
Family: Cucurbitaceae
Genus: *Cucumis*
Species: *Cucumis dipsaceus* (L.)
Local Name: Kakrol
English Name: Teasel gourd,
Hedgehog gourd

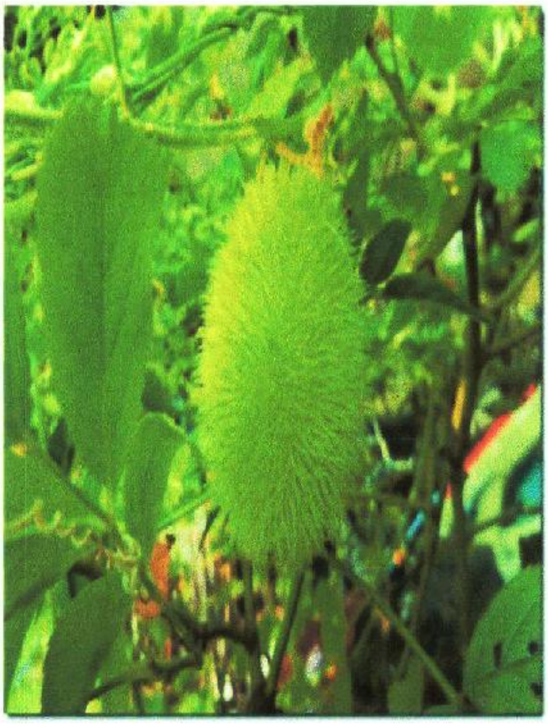

Fig 4: *Cucumis dipsaceus*

3.3.2 Uses

The fruit of *Cucumis dipsaceus* is quite popular as a vegetable in Asia and Africa. Its fruits are consumed by frying or cooking, with or without meat or fish. The vegetable is rich in calcium, phosphorus, iron and carotene. The seed contains saponin. The roots and fruits of *C. dipsaceus* contain cucurbitacin, a very bitter principle. It is used to remove lumps, eliminate fluid and relieve jaundice, acute and chronic viral hepatitis, liver cancer, persistent dyspepsia, epilepsy due to wind phlegm and for the treatment of tumors. Cucurbitacin is anti-carcinogenic and promote body immunity (Miro, 2006).

3.4 Sample Name: *Ficus hispida*

A small laticiferous tree with hispid broadly ovate coriaceous leaves and bunches of round hypanthodium coming out other main trunk and branches, grows in almost all districts.

3.4.1 Scientific classification

Kingdom: Plantae

Phylum: Magnoliophyta

Class: Angiospermae

Order: Fagales

Family: Moraceae

Genus: *Ficus*

Species: *Ficus hispida* (L.)

Local Name: Dumur

English Name: Creeping fig.

Fig 5: *Ficus hispida*

3.4.2 Uses

All parts of *Ficus hispida* are reported to be bitter, cooling, acrid, astringent to the bowels, antidysentric and active against pitta, leukoderma, fever, alopesia, ulcers, biliousness, psoriasis, anemia, piles, jaundice, hemorrhage of the nose and mouth and diseases of the blood. The fruit acts as a coolant, aphrodisiac, tonic, lactagogue and emetic; also causes "Vata" and constipation (Kirtikar and Basu, 1987). Fruits are astringent, tonic and lactagogue. Leaves are used for poulticing boils. Burks and seeds are purgative and emetic (Ghani, 1998). A mixture of honey and the juice of these fruit is a good antihemorrhagic (Sergio and Sanchez, 2002) whereas the barks and leaves are having antidiarrhoeal (Khuman et al., 1995; Subhash et al., 2002), antidiabetic (Ghosh et al., 2004), cardio protective (Shanmugarajan and Arunsundar, 2008), antipyretic, astringent and anticonvulsant activity.

3.5 Sample Name: *Lablab purpureus*

A climbing twiner with trifoliate leaves, lilac flowers and flat, curved, oblong fruits extensively cultivated as a vegetable crop throughout the country. It has potential to improve nutrition, boost food security, foster rural development and support sustainable land care.

3.5.1 Scientific classification

Kingdom: Plantae
Phylum: Magnoliophyta
Class: Angiospermae
Order: Fabales
Family: Leguminosaceae
Genus: *Lablab*
Species: *Lablab purpureus* (L.)
Local Name: Sim
English Name: Bean

Fig 6: *Lablab purpureus*

3.5.2 Uses

Lablab is a dual-purpose legume. It is traditionally grown as a pulse crop for human consumption. Flowers and immature pods also used as a vegetable. It is also used as a fodder legume, green manure, cover crop and in cut-and-carry systems and as a concentrate feed. It can be incorporated into cereal cropping systems as a legume ley to address soil fertility decline and is used as an intercrop species with maize to provide better legume/Stover feed quality. Leaves are regarded asalecxicpharmac (antidote to position) and emmenagogue. They cure ringworm and colic. Seeds are claimed to be tonic aphrodisiac, diuretic, febrifuge and stomachie. Seeds are also used in inflammations. Plant pacifies vitiated vata, pitta, inflammation, colic, and urinary retention. The seed powder increases milk production of the livestock which is indirectly beneficial to humans. It is an excellent source of iron and magnesium and also a good source of phosphorus zinc and copper (Ghani, 1998).

3.6 Sample Name: *Lagenaria siceraria*

A luxuriantly growing large climbing or creeping plant with large hirsute palmate leaves, white epigenous flowers and large fleshy fruits cultivated as vegetable crop throughout the country.

3.6.1 Scientific classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Cucurbitales
Family: Cucurbitaceae
Genus: *Lagenaria*
Species: *Lagenaria siceraria (*M.)
English Name: Bottle gourd

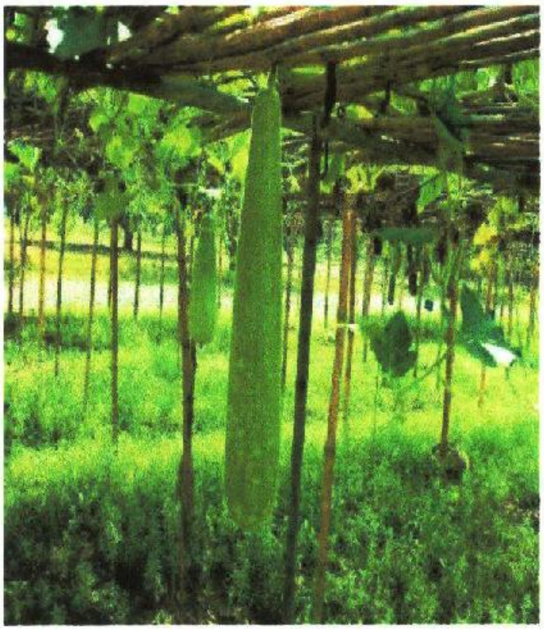

Fig 7: *Lagenaria siceraria*

3.6.1 Uses

L.siceraria cures pain, ulcers, fever, asthma and other bronchial disorders. Its fruit is traditionally used for its cardioprotective, cardiotonic, general tonic and aphrodisiac properties. The seed oil is applied in headache. The stem bark and the rind of the fruit are diuretic. The fruit is antilithic, diuretic, emetic and refrigerant. The juice of the fruit is used in the treatment of stomach acidity, indigestion and ulcers. The seed is vermifuge. It has antioxidant, cardio-protective, anti-hyperlipidemic, anthelmintic, anti-Inflammatory, hepato protective, anti-diarrhoeal, anti-diabetic, cardio protective, antipyretic, anti-HIV astringent and anticonvulsant activity (Gorasiya et al., 2011). Fruit pulp is cooling antibilious, diuretic, emetic and puragative. Decoction of leaves, mixed with sugar, is given in jaundice. Cooked pulp is used in cholera. Seeds are nutritive and diuretic (Ghani, 1998).

3.7 Sample Name: *Luffa acutangula*

A long tendril climber with soft petiolate lobed palmate leaves and edible long fruits having acutely longitudinal ridges is cultivated as a vegetable crop in all parts of the country. The plant contains a bitter substance, luffin (Ghani, 1998).

3.7.1 Scientific classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Cucurbitales
Family: Cucurbitaceae
Genus: *Luffa*
Species: *Luffa acutangula* (L.)
Local Name: Jhinga
English Name: Ridge luffa

Fig 8: *Luffa acutangula*

3.7.2 Uses

The fruit section of *L. acutangula* marketed as luffa or loofah, the sponge is used like a body scrub. Its juice is used as a natural remedy for jaundice. The juice is obtained by pounding the bitter luffa and squeezing it through a cloth. Bitter luffa seeds and dry crusts are also available and can be used for the same purpose. Juice of the leaves is applied to eyes in granular conjunctivitis and excessive meibomian secretion. Paste of leaves is demulcent diuretic. Seeds are emetic and puragetive, applied locally to splenitis and leprosy (Ghani, 1998). The fully developed fruit is the source of the loofah scrubbing sponge which is used in bathrooms and kitchens as a sponge tool.

3.8 Sample Name: *Luffa aegyptiaca*

Luffa aegyptiaca is a species of Luffa commonly known as Smooth Luffa, Egyptian Luffa. It is native to northern Africa, but is now found in many tropical and subtropical areas of the world. It is cultivated and grown for its fruit. The fruit resembles a cucumber.

3.8.1 Scientific classification

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Cucurbitales

Family: Cucurbitaceae

Genus: *Luffa*

Species: *Luffa aegyptiaca* (M.).

Local Name: Dhundol

English Name: Smooth Luffa, Sponge gourd

Fig 9: ***Luffa aegyptiaca***

3.8.2 Uses

Young edible fruits are cool costive, demulcent, appetizer and exitative of mind, bile and phlegm. Seeds are emetic and cathartic. Oinment prepared from fruit pulp is used in the treatment of skin disorders around the anus in patients with haemorrhoids (Ghani, 1998). Fried gourd flowers are quite a delicacy and the raw flowers are a nice addition to tossed salads. It can be used as packing material, for making crafts and as filters. Edible oil can be extracted from the seeds. The fruit section may be used as a bath or kitchen sponge after being processed to remove everything but the network of xylem. In Paraguay, panels are made out of *L. aegyptiaca* combined with other vegetable matter and recycled plastic. They are used to create furniture and construct houses. The juice of the fruit is also used as an effective natural remedy for jaundice and rheumatic pains (Ghani, 1998).

3.9 Sample Name: *Momordica charantia*

A creeping or climbing weak annual herb with deeply lobed leaves, yellow epigenous flowers, ovate or obolong ovate, tuberculed fruits, cultivated extensively as a vegetable crop throughout the country .

3.9.1 Scientific classification

Kingdom: Plantae
Subkingdom: Tracheobionta
Super division: Spermatophyta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Dilleniidae
Order: Violales
Family: Cucurbitaceae
Genus: *Momordica*
Species: *Momordica charantia* (L.)
Local Name: Ucca
English Name: Bitter gourd

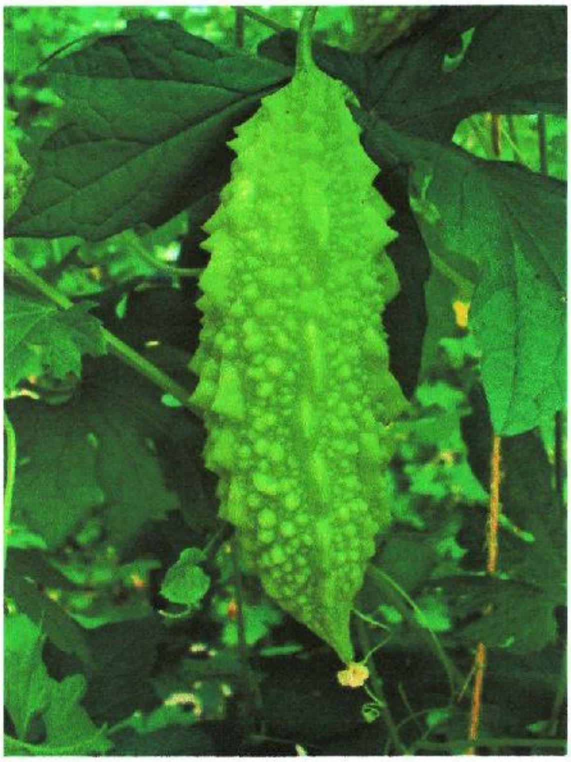

Fig 10: *Momordica charantia*

3.9.2 Uses

Bitter melon is used for tumors, wounds, rheumatism, malaria, vaginal discharge, inflammation, menstrual problems, diabetes, colic, fevers and worms. It is also used to induce abortions and as an aphrodisiac. It is prepared into a topical remedy for the skin to treat vaginitis, hemorrhoids, scabies, itchy rashes, eczema, leprosy and other skin problems. In Mexico, the entire plant is used for diabetes and dysentery; the root is a reputed aphrodisiac. In Peruvian herbal medicine, the leaf or aerial parts of the plant are used to treat measles, malaria and all types of inflammation. In Nicaragua, the leaf is commonly used for stomach pain, diabetes, fevers, colds, coughs, headaches, malaria, skin complaints, menstrual disorders, aches and pains, hypertension, infections and as an aid in child birth (Ghani, 1998).

3.10 Sample Name: *Solanum melongena*

The eggplant or brinjal (*Solanum melongena*) is a plant of the family Solanaceae and genus Solanum. The flowers are white to purple, with a five-lobed corolla and yellow stamens. The fruit is fleshy, has a meaty texture, but much larger in cultivated forms. The fruit is botanically classified as a berry and contains numerous small, soft seeds which are edible, but have a bitter taste because they contain nicotinoid alkaloids.

3.10.1 Scientific classification

Kingdom: Plantae

Subkingdom: Viridaeplantae

Class: Magnoliopsida

Order: Solanales

Family: Solanaceae

Genus: *Solanum*

Species: *Solanum melongena* (L.)

Local Name: Begun

English Name: Eggplant, Brinjal

Fig 11: *Solanum melongena*

3.10.2 Uses

Eggplant is used to check diabetes (Tang et al., 2008). It reduces swellings of legs, relieves hemorrhoid discomfort and acts as sweat preventive. Brinjal effectively treats enlarged spleen caused due to malaria (Choudhary and Gaur, 2009). Eating brinjal is an effective way of maintaining blood cholesterol levels. Taking soup made of mashed brinjal and tomato helps in digestion and increases appetite. Brinjal effectively treats gas, congestion, phlegm and cures insomnia (Choudhary and Gaur, 2009). It has antipyretic and analgesic activity (Mutalik et al., 2003). It contains chemicals that prevent cancer in animals.

3.11 Sample Name: *Trichosanthes cucumerina*

Trichosanthes cucumerina belongs to the family Cucurbitaceae and is distributed throughout India, Bangladesh, Sri Lanka, Burma, Malaysia and Australia. A tendril climbing herb with subreni form cordate, lobed leaves, white flower having multified corolla and long cylindrical white or green fruits is cultivated throughout the country as a vegetable plant.

3.11.1 Scientific classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Cucurbitales
Family: Cucurbitaceae
Genus: *Trichosanthes*
Species: *Trichosanthes cucumerina* (L.)
Local Name: Khusi/ chichinge
English Name: Snake gourd

Fig 12: *Trichosanthes cucumerina*

3.11.2 Uses

Trichosanthes cucumerina is highly bitter in taste, the bitter taste may supposed to contain medicinal properties (Choudhury, 1967) hence being used in various treatments as a cordiotonic, antipyretic, antiperiodic, useful for intestinal worms and leaf juice rubbed over the liver in remittent fever (Kirtikar and Basu, 2000) skin disease (Chopra et al., 1969) appetizer, laxative, aphrodisiac and blood purifier (Shivarajan and Indira, 1994) root is used to cure bronchitis, headache and boils. Leaves, for biliousness, emetic, externally applied over bald patches of alopecia (Anonymous, 1976) to reduce congestion on congestive cardiac failure (Pullaih, 2006). Decoctions of leaves and stems are used in the treatment of bilious disorders and skin disease. They are also used as cardiac tonic and emmenagogue. Seeds and roots are used for the expulsion of intestinal worms and in the treatment of diarrhea and syphilis (Ghani, 1998).

3.12 Sample Name: *Trichosanthes dioica*

The plant has harsh broad, sinate or cordate five-lobed and serrated leaves upper surface downy, tendrils bifid; flowers are white and fringed; fruit is oblong, narrow and pointed at both the ends, 4-8 cms long, glaucous, of a greenish white color and marked with few irregular, longitudinal strips. The root has bitter active principles which are strongly laxative; it is likely that cucurbitacins of steroidal structure are also present in this plant, as in other members of the same natural order.

3.12.1Scientific classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Cucurbitales
Family: Cucurbitaceae
Genus: *Trichosanthes*
Species: *Trichosanthes dioica* (R.)
Local Name: Potol
English Name: Pointed gourd

Fig 13: *Trichosanthes dioica*

3.12.2Uses

It is a rich source of carbohydrates, vitamin A, and vitamin C and major nutrients and certain essential trace elements such as magnesium, potassium, copper, sulfur, and chlorine which that seem an important role in human physiology. Traditional use of *Trichosanthes dioica* in folk medicines for treating diabetes mellitus (Sharma et al., 2008) and presence of flavonoids (Rahman and Moon, 2007) in addition to trace elements viz. Cu, K and Mg etc. (Sharma et al., 2008) are responsible for anti-diabetic activity of plants (Kar et al., 1999). Leaves are used as aperients, febrifuge, laxative, antibilious and a remedy for spermatorrhoe.Fresh juice of unripe fruits is used as cooling and laxative adjunct to alternative medicines (Ghani, 1998).

3.13 Sample Name: *Vigna unguiculata*

The black-eyed pea, also called black-eyed bean, is a subspecies of the cowpea, grown around the world for its medium-sized edible bean. They are one of the most important food legume crops in the semi-arid tropics. A drought-tolerant and warm-weather crop, they are well-adapted to the drier regions of the tropics, where other food legumes do not perform well. It also has the useful ability to fix atmospheric nitrogen through its root nodules and it grows well in poor soils with more than 85% sand and with less than 0.2% organic matter and low levels of phosphorus (Singh, 2003). It is shade tolerant and compatible as an intercrop with maize, millet, sorghum, sugarcane and cotton. This makes black-eyed pea an important component of traditional intercropping systems.

3.13.1 Scientific classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Fabales
Family: Fabaceae
Genus: *Vigna*
Species: *Vigna unguiculata* (L.)
Local Name: Barboti
English name: Black eyed pea

Fig 14: ***Vigna unguiculata***

3.13.2 Uses

The crisp tender pods are eaten both fresh and cooked. They are a good source of protein, vitamin, thiamine, riboflavin, iron, phosphorus and a very good source of vitamin C, folate, magnesium, manganese. Use of legumes in the human diet can also be problematic. Legume seeds generally contain 20% to 30% protein and are Lys rich, complementing the nutritional profiles of cereals and tubers in the diet (Singh, 2003).

CHAPTER FOUR

MATERIALS AND METHODS

CHAPTER FOUR

MATERIALS AND METHODS

4.1 Materials

4.1.1 Collection of samples

The common fruity vegetables were collected from the local market of Abyanagar upazilla under Jessore district in the month of June 2012-November, 2012.

4.1.2 Preparation of samples

Collected vegetables were washed by distilled water (DW), to remove undesirable materials. After removing excess water, samples were sliced into small pieces. Then sliced vegetables were weighed by balance.

4.1.3 Preparation of Extract

The processed fruity vegetables were air dried for 15-20 days under sunlight with shadow until all the water evaporated. After getting fragile form, the sliced fruity vegetables were kept into airtight bottle. Two grams of sliced dried sample was taken in each of the five conical flasks which had 40mL of deionized water. All five conical flasks were kept in room temperature for 24 hours. Then they were boiled, pressure cooked, autoclaved or microwave oven cooked for different time duration (2, 5, 10, 20) minutes separately. The 5^{th} sample was kept normal or without any processing. The five separate samples were homogenized separately and filtered by Whatman No. 1 filter paper. The filtrate adjusted to 50 mL by adding DW. Finally, this 50 mL sample was used for conducting the experiments.

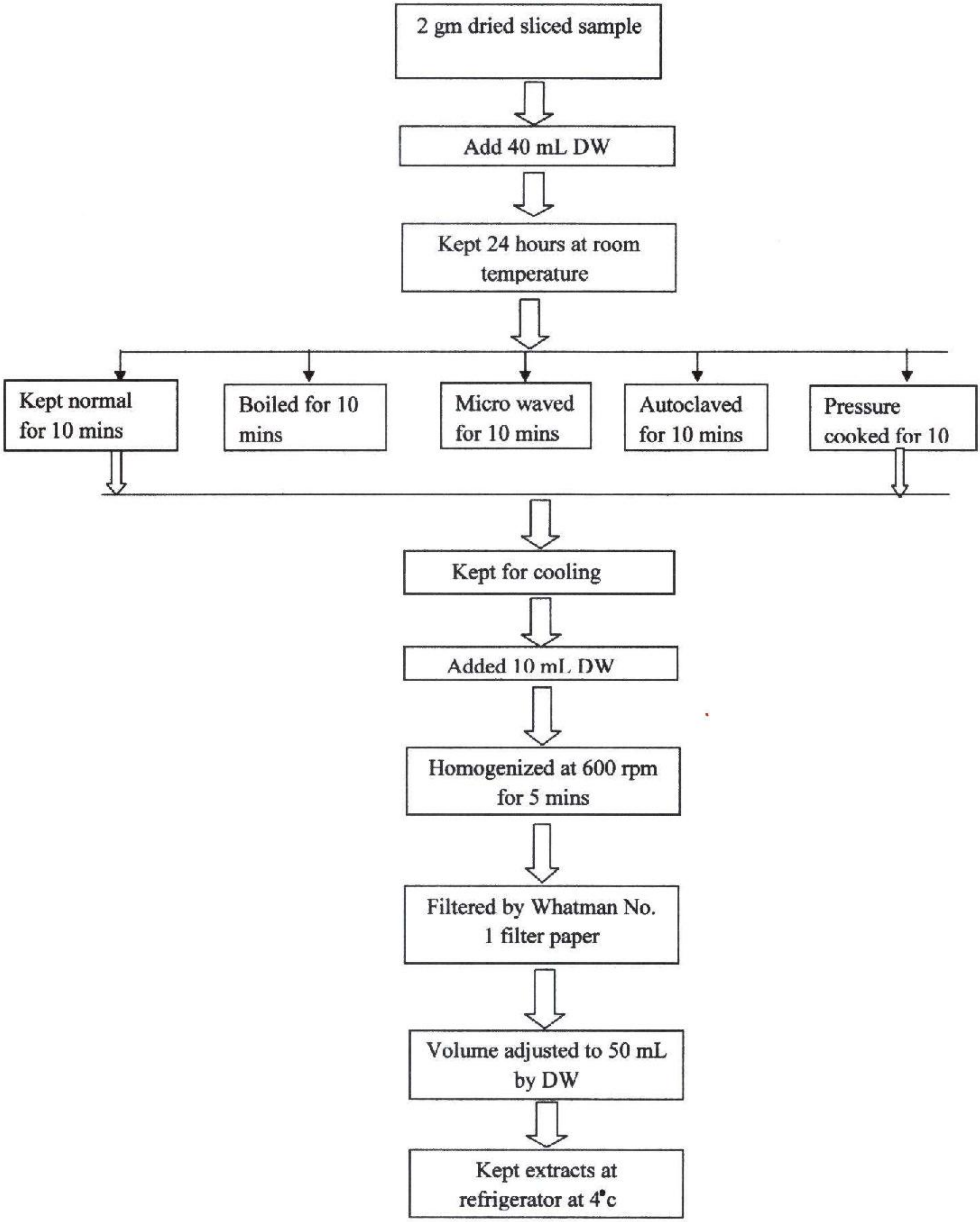

Figure 15: Schematic flow chart of sample preparation

4.3 Chemicals, Glass wares and Instruments

4.3.1 Chemicals

1. Gallic Acid.
2. Sodium Carbonate.
3. Folin (ciocalteu's phenol reagent).
4. 200mM Phosphate Buffer, pH 6.6 (0.2mM Na_2HPO_4, 0.2 mM NaH_2PO_4).
5. Potassium Ferricyanide.
6. Trichloroacetic Acid.
7. L-Ascorbic Acid.
8. Ferric Chloride.
9. Sulfuric Acid.
10. Sodiumdihydrogen Phosphate.
11. Ammonium Molybdate.
12. 100% Ethanol
13. 0.5 Sodium acetate buffer pH→5.5
14. DPPH (2, 2-diphenyl-1-picrylhydrazyl)
15. Distilled Water

4.3.2 Instruments

1. Test tubes
2. Beakers
3. Magnetic stirrer
4. UV spectrophotometer (single beam)
5. Electronic balance
6. conical flask
7. Micro-oven
8. Autoclave
9. Micropipettes
10. P^H meter
11. Homogenizer
12. Water distillation chamber
13. Pressure Cooker

14. Centrifuge
15. Centrifuge tube
16. Whatman No. 1 filter paper
17. Vortex mixture.

4.4 Methods

4.4.1 Cooking methods and time duration

In the present study four cooking methods were used. They were: boiling, microwaving, pressure cooking and autoclaving. These cooking methods were applied for (2, 5, 10 and 20) minutes.

4.4.2 Total phenolics and antioxidant activity

Total phenolics content was determined according to the Folin-Ciocalteu procedure and antioxidant activity were measured by using DPPH free radical scavenging activity, reducing power and total antioxidant capacity.

4.4.2.1 Determination of total phenolic content

The total concentration of phenolics (TPC) in the extracts was determined according to the Folin-Ciocalteu method (Ough and Amerine, 1988) with gallic acid (GA) as the standard and expressed (mg) as gallic acid equivalents (GAE)/g of extract (Aoshima and Ayabe, 2007; Hossain et al., 2009).

4.4.2.2 Determination of DPPH free radical scavenging activity

The determination of DPPH free radical scavenging activity was determined according to the method of (Blios, 1958; Aoshima et al., 2004).

4.4.2.3 Reducing Power Determination

The reducing power of the extracts was determined according to the method of Oyaizu (1986).

4.4.2.4 Total Antioxidant Capacity Measurement

The total antioxidant capacity of the extracts was determined according to the method of Prieto et al., (1999).

4.5 Statistical analysis

Samples were prepared in 3 replicates and analyzed statistically using the Statistical Package for the Social Sciences (SPSS) database, version 16.0, submitting the data to a simple 1 factor analysis of variance (ANOVA) after verifying the existence of a highly significant interaction between the type of cooking methods, cooking time and type of vegetable in a prior 2-factor variance analysis. Analysis of variance (ANOVA) was performed and the mean separation was done by SPSS database ($p < 0.05$).

CHAPTER FIVE

RESULTS

CHAPTER FIVE
RESULTS

5.1 Total phenolics content (TPH)

In the present study, effect of cooking methods (boiling, microwaving, pressure cooking and autoclaving) with different time duration (2, 5, 10 and 20 minutes) was observed on total phenolics of 13 common fruity vegetables in Bangladesh. Each sample was measured at 700 nm optical density (O.D). **Table 05** showed total phenolics content of fruity vegetables cooked at different methods with different time duration. In general, cooked fruity vegetables showed increased amount of polyphenols than uncooked in every time duration. Cooking at 2 minutes showed highest amount of polyphenols, which were decreased with increasing time duration and showed lowest at 20 minutes. **Table 06** showed percentage (%) of change of total phenolics of fruity vegetables cooked at different methods with different time duration.

Among the methods, highest amount of polyphenols was in autoclaving, whereas microwaving and pressure cooking occupies intermediate position followed by boiling produced lowest results. Among the vegetables, *L. acutangula* showed highest content of polyphenols followed *by F. hispida* and *T. cucumerina* whereas lowest at *T. dioica* followed by *L. purpureus* and *C. mixta*. They were graded as, *L. acutangula* > *F. hispida* > *T. cucumerina* > *V. unguiculata* > *A. esculentus* > *S. melongena* > *L. siceraria* > *L. aegyptiaca* > *M. charantia* > *C. dipsaceus* > C. *mixta* > *L. purpureus* > *T. dioica*.

5.2 Antioxidant activity

5.2.1 DPPH free radical scavenging activity

Table 07 showed Percentage (%) DPPH free radical scavenging activity of fruity vegetables cooked at different methods with different time duration. All samples were measured at 517 nm optical density (O.D). In general, cooked fruity vegetables showed increased DPPH free radical scavenging activity at 2 minutes than uncooked whereas decreased with increasing time duration. The activity was highest at 2 minutes whereas lowest at 20 minutes. **Table 08** showed Percentage (%) of change of DPPH free radical scavenging activity (%) of fruity vegetables cooked at different methods with different time duration.

Autoclaving showed highest activity in DPPH free radical scavenging followed by pressure cooking, microwaving and boiling. Among the vegetables, *T. dioica* showed highest scavenging of DPPH followed by *C. mixta* and *A. esculentus* whereas *C. dipsaceus* was lowest followed by *T. cucumerina* and *V. unguiculata.* They were graded as, *T. dioica* > *C. mixta* > *A. esculentus* > *L. siceraria* > *L. acutangula* > *L. purpureus* > *S. melongena* > *F. hispida* > *M. charantia* > *L. aegyptiaca* > *V. unguiculata* > *T. cucumerina* > *C. dipsaceus.*

5.2.2 Reducing power activity

Reducing power activity of the fruity vegetables was measured by potassium ferrycyanide reduction method where optical density of the samples was measured at 700 nm. **Table 09** showed reducing power activity of fruity vegetables cooked at different methods with different time duration. Fruity vegetables cooked at 2, 5, and 10 minutes showed higher reducing power activity than uncooked. Reducing power activity decreased as time increased which was highest at 2 minutes and lowest at 20 minutes. **Table 10** showed percentage (%) of change of reducing power activity of fruity vegetables cooked at different methods with different time duration. Among the methods, autoclaving made highest results followed by pressure cooking, microwaving and boiling. Here, *L. siceraria* showed highest reducing power activity followed by *A. esculentus* and *L. purpureus* whereas *C. mixta* was lowest followed by *M. charantia* and *L. acutangula*. They were graded as, *L. siceraria* > *A. esculentus* > *L. purpureus* > *T. dioica* > *V. unguiculata* > *S. melongena* > *C. dipsaceus* > *L. aegyptiaca* > *T. cucumerina* > *F. hispida* > *L. acutangula* > *M. charantia* > *C. mixta.*

5.3.3 Total Antioxidant capacity (TAC)

Total antioxidant capacity of fruity vegetables for different cooking methods with different time duration expressed as the ascorbic acid equivalents (AAE)/g and gallic acid equivalents (GAE)/g which was determined at 618 O.D. **Table 11** showed total antioxidant capacity (AA) of fruity vegetables cooked at different methods with different time duration. **Table 13** showed total antioxidant capacity (GA) of fruity vegetables cooked at different methods with different time duration. The highest antioxidant capacity was at 10 minutes cooking whereas lowest at 2 minutes. Antioxidant capacity of cooked vegetables gradually increased with time duration at which 10 minutes cooking is highest. After that it gradually decreased and in 20 minutes cooking it was lower than uncooked. **Table 12** showed percentage (%) of change of total antioxidant capacity (AA) of fruity vegetables cooked at different methods with different time duration. **Table 14** showed percentage (%) of change of total antioxidant capacity (GA) of fruity vegetables cooked at different methods with different time duration.

In the group of methods, autoclave showed highest activity followed by microwaving, pressure cooking and boiling. Among vegetables, *S. melongena* showed highest total antioxidant capacity followed by A. *esculentus* and *T. dioica* whereas *M. charantia* showed lowest followed by *T. cucumerina* and *V. unguiculata*. They were graded as, *S. melongena* > A. *esculentus* > *T. dioica* > L. *acutangula* > *L. aegyptiaca* > *C. dipsaceus* > *L. purpureus* > *L. siceraria* > *F. hispida* > C. *mixta* > *V. unguiculata* > *T. cucumerina* > M. *charantia.*

Table 05: Total phenolics content of fruity vegetables cooked at different methods with different time duration.

Vegetables↓			Phenolics mg GAE/g dw			
	Uncooked	Cooking method	Time in mins			
			2	5	10	20
A. esculentus	4.8 ± .08^{a}	B	7.8 ± .20^{b}	6.7 ± .15^{c}	6.2 ± .11^{d}	5.4 ± .19^{e}
		O	9.8 ± .13^{b}	7.7 ± .12^{c}	6.0 ± .19^{d}	5.5 ±.01^{e}
		P	8.6 ± .15^{b}	7.8 ± .22^{c}	6.5 ± .19^{d}	5.7 ± .02^{e}
		A	9.2 ± .15^{b}	8.2 ± .12^{c}	7.6 ± .09^{d}	6.0 ± .15^{e}
C. mixta	4.4 ± .04^{a}	B	5.0 ± .11^{b}	4.7 ± .11^{a}	4.5 ± .08^{a}	3.8 ± .15^{d}
		O	5.3 ± .06^{b}	4.9 ± .11^{c}	4.4 ± .21^{d}	4.4 ± .09^{e}
		P	5.3 ± .18^{b}	4.0 ± .05^{c}	3.8 ± .07^{d}	3.7 ± .06^{d}
		A	6.2 ± .11^{b}	5.3 ± .14^{c}	5.2 ± .09^{c}	5.2 ± .04^{c}
C. dipsaceus	4.1 ± .05^{a}	B	4.5 ± .10^{b}	4.4 ± .11^{c}	4.4 ± .09^{c}	4.3 ± .15^{a}
		O	4.5 ± .02^{b}	4.5 ± .16^{b}	4.2 ± .05^{a}	4.0 ± .01^{a}
		P	4.4 ± .20^{b}	4.3 ± .13^{ab}	4.2 ± .10^{a}	4.0 ± .05^{c}
		A	6.0 ± .10^{b}	5.8 ± .23^{c}	5.6 ± .10^{c}	4.1 ± .05^{a}
F. hispida	3.7 ± .03^{a}	B	8.4 ± .18^{b}	6.7 ± .17^{c}	6.0 ± .09^{d}	5.9 ± .16^{d}
		O	7.8 ± .21^{b}	6.8 ± .10^{c}	6.0 ± .23^{d}	5.3 ± .07^{e}
		P	8.2 ± .16^{b}	7.0 ± .10^{c}	5.5 ± .01^{d}	4.8 ± .18^{e}
		A	10.7 ± .09^{b}	9.3 ± .11^{c}	9.0 ± .05^{d}	8.7 ± .12^{e}
L. purpureus	8.0 ± .01^{a}	B	8.7 ± .21^{b}	8.2 ± .05^{b}	8.0 ± .02^{a}	7.4 ± .02^{c}
		O	8.4 ± .09^{a}	8.4 ± .02^{b}	7.8 ± .19^{c}	7.2 ± .03^{d}
		P	8.4 ± .22^{a}	8.2 ± .11^{b}	8.0 ± .10^{a}	6.5 ± .16^{c}
		A	12.3 ± .11^{b}	8.9 ± .06^{c}	8.2 ± .09^{d}	8.1 ± .21^{a}
L. siceraria	6.8 ± .13^{a}	B	10.0 ± .13^{b}	9.4 ± .06^{b}	7.9 ± .11^{c}	7.2 ± .14^{d}
		O	10.2 ± .13^{b}	9.6 ± .09^{c}	8.4 ± .17^{d}	7.6 ± .13^{e}
		P	11.9 ± .01^{b}	9.9 ± .12^{c}	9.4 ± .17^{d}	6.3 ± .04^{e}
		A	10.2 ± .07^{b}	9.7 ± .04^{c}	8.4 ± .05^{d}	5.7 ± .01^{e}
L. acutangula	2.7 ± .09^{a}	B	7.6 ± .20^{b}	6.8 ± .06^{c}	6.3 ± .03^{d}	4.0 ± .04^{e}
		O	7.2 ± .12^{b}	6.1 ± .10^{c}	5.7 ± .14^{d}	5.4 ± .17^{e}
		P	7.5 ± .12^{b}	7.4 ± .15^{b}	6.4 ± .11^{c}	5.4 ± .04^{d}
		A	8.6 ± .04^{b}	8.2 ± .04^{c}	7.6 ± .17^{d}	6.7 ± .04^{e}
L. aegyptiaca	3.4 ± .03^{a}	B	4.4 ± .10^{b}	4.4 ± .19^{b}	3.8 ± .01^{a}	2.6 ± .12^{c}
		O	4.6 ± .05^{b}	4.5 ± .05^{c}	4.3 ± .08^{d}	3.8 ± .17^{e}
		P	4.8 ± .15^{b}	4.7 ± .12^{b}	4.6 ± .03^{c}	3.5 ± .01^{a}
		A	6.0 ± .22^{b}	5.6 ± .17^{c}	5.0 ± .07^{d}	3.9 ± .15^{e}
M. charantia	3.0 ± .05^{a}	B	4.7 ± .04^{b}	4.5 ± .13^{b}	3.1 ± .06^{a}	3.1 ± .11^{a}
		O	5.0 ± .10^{b}	3.7 ± .05^{c}	3.4 ± .15^{c}	2.8 ± .04^{d}
		P	5.1 ± .18^{b}	3.9 ±. 10^{c}	3.1 ± .10^{a}	2.8 ± .01^{c}
		A	4.7 ± .07^{b}	4.5 ± .12^{c}	3.4 ± .06^{d}	3.4 ± .04^{d}
S. melongena	4.6 ± .07^{a}	B	8.5 ± .01^{b}	6.1 ± .09^{c}	5.5 ± .11^{d}	5.0 ± .03^{c}
		O	8.1 ± .02^{b}	5.6 ± .14^{c}	5.6 ± .08^{d}	5.1 ± .06^{c}
		P	8.1 ± .09^{b}	7.4 ± .13^{c}	5.2 ± .17^{d}	5.2 ± .05^{d}
		A	8.1 ± .20^{b}	7.8 ± .02^{c}	5.5 ± .11^{d}	5.1 ± .02^{d}
T. cucumerina	4.3 ± .15^{a}	B	9.9 ± .21^{b}	6.9 ± .06^{c}	5.7 ± .07^{d}	4.2 ± .05^{a}
		O	7.6 ± .16^{b}	7.1 ± .11^{c}	5.7 ± .20^{d}	3.8 ± .15^{e}
		P	10.3 ± .16^{b}	8.0 ± .10^{c}	6.0 ± .13^{d}	2.7 ± .01^{e}
		A	9.5 ± .04^{b}	7.0 ± .08^{c}	5.6 ± .01^{d}	5.0 ± .07^{c}
T. dioica	8.1 ± .13^{a}	B	8.8± .20^{b}	8.5 ± .17^{a}	8.0 ± .05^{c}	7.3 ± .20^{d}
		O	8.0 ± .03^{a}	7.7 ± .02^{b}	7.2 ± .19^{c}	6.8 ± .12^{d}
		P	8.7 ± .17^{b}	8.0 ± .19^{a}	7.8 ± .13^{c}	6.8 ± .03^{d}
		A	9.8 ± .06^{b}	8.6 ± .19^{a}	7.8 ± .21^{c}	7.0 ± .12^{d}
V. unguiculata	4.3 ± .16^{a}	B	9.3 ± .04^{b}	5.6 ± .15^{c}	5.4 ± .10^{c}	4.8 ± .12^{d}
		O	9.7 ± .16^{b}	7.1 ± .06^{c}	6.5 ± .08^{d}	5.9 ± .11^{e}
		P	6.3 ± .09^{b}	5.8 ± .16^{c}	5.0 ± .01^{d}	4.5 ± .10^{d}
		A	8.5 ± .17^{b}	6.2 ± .08^{c}	5.8 ± .12^{c}	5.6 ± .02^{d}

B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$).

Table 06: Percentage (%) of change of total phenolics of fruity vegetables cooked at different methods with different time duration.

Vegetables↓	Phenolics mg GAE/g dv				
	Cooking method	Time in mins			
		2 (%)	5 (%)	10 (%)	20 (%)
A. esculentus	B	162.4 ± 4.2^{b}	140.1 ± 3.1^{c}	128.1 ± 2.3^{d}	112.3 ± 4.0^{e}
	O	203.4 ± 2.7^{b}	159.7 ± 2.5^{c}	125.0 ± 4.0^{d}	$113.8 \pm .21^{e}$
	P	178.4 ± 3.1^{b}	163.1 ± 4.6^{c}	136.3 ± 4.0^{d}	$119.2 \pm .42^{e}$
	A	191.8 ± 3.1^{b}	170.4 ± 2.5^{c}	159.0 ± 1.9^{d}	125.2 ± 3.1^{e}
C. mixta	B	114.1 ± 2.5^{b}	107.4 ± 2.5^{a}	103.0 ± 1.8^{a}	85.7 ± 3.4^{d}
	O	121.1 ± 1.4^{b}	110.4 ± 2.5^{c}	100.7 ± 4.8^{d}	99.3 ± 2.1^{e}
	P	119.9 ± 4.1^{b}	92.0 ± 1.1^{c}	87.1 ± 1.6^{d}	84.5 ± 1.4^{d}
	A	140.8 ± 2.5^{b}	120.8 ± 3.2^{c}	118.8 ± 2.1^{c}	$117.9 \pm .91^{c}$
C. dipsaceus	B	110.3 ± 2.5^{b}	108.0 ± 2.7^{c}	107.6 ± 2.2^{c}	104.4 ± 3.7^{a}
	O	$110.4 \pm .50^{b}$	109.9 ± 3.9^{b}	103.8 ± 1.2^{a}	$100.1 \pm .25^{a}$
	P	108.6 ± 4.9^{b}	104.4 ± 3.2^{ab}	102.2 ± 2.5^{a}	97.8 ± 1.2^{c}
	A	147.8 ± 2.5^{b}	141.2 ± 5.6^{c}	136.6 ± 2.5^{c}	100.7 ± 1.2^{a}
F. hispida	B	223.6 ± 4.8^{b}	178.9 ± 4.6^{c}	161.0 ± 2.4^{d}	158.1 ± 4.3^{d}
	O	207.5 ± 5.6^{b}	183.2 ± 2.8^{c}	160.6 ± 6.2^{d}	142.0 ± 1.9^{e}
	P	220.0 ± 4.3^{b}	187.0 ± 2.7^{c}	147.8 ± 1.3^{d}	127.3 ± 4.8^{e}
	A	286.4 ± 2.4^{b}	250.2 ± 2.9^{c}	$239.9 \pm .27^{d}$	233.0 ± 3.2^{e}
L. purpureus	B	108.0 ± 2.6^{b}	$102.7 \pm .62^{b}$	$100.1 \pm .25^{a}$	$92.9 \pm .25^{c}$
	O	105.1 ± 1.1^{a}	$105.0 \pm .25^{b}$	97.8 ± 2.4^{c}	$90.1 \pm .37^{d}$
	P	105.8 ± 1.4^{a}	102.2 ± 1.4^{b}	99.9 ± 1.3^{a}	81.6 ± 2.0^{c}
	A	153.7 ± 2.7^{b}	$111.1 \pm .75^{c}$	101.9 ± 1.1^{d}	101.2 ± 2.6^{a}
L. siceraria	B	147.5 ± 1.9^{b}	$136.9 \pm .88^{b}$	115.3 ± 1.6^{c}	105.2 ± 2.1^{d}
	O	149.7 ± 1.9^{b}	139.9 ± 1.3^{c}	116.3 ± 2.5^{d}	111.6 ± 1.9^{e}
	P	$173.9 \pm .15^{b}$	144.0 ± 1.8^{c}	137.3 ± 2.5^{d}	$91.8 \pm .60^{e}$
	A	149.1 ± 1.0^{b}	$144.9 \pm .60^{c}$	$122.1 \pm .73^{d}$	83.4 ± 0.15^{e}
L. acutangula	B	277.5 ± 7.3^{b}	249.1 ± 2.2^{c}	232.7 ± 1.1^{d}	145.3 ± 1.5^{e}
	O	262.5 ± 4.4^{b}	225.7 ± 3.7^{c}	210.8 ± 5.1^{d}	199.3 ± 6.2^{e}
	P	276.8 ± 4.4^{b}	270.0 ± 5.5^{b}	236.5 ± 4.0^{c}	197.2 ± 1.5^{d}
	A	317.1 ± 1.5^{b}	301.3 ± 1.5^{c}	279.4 ± 6.2^{d}	245.1 ± 1.5^{e}
L. aegyptiaca	B	128.2 ± 2.9^{b}	128.5 ± 5.5^{b}	$109.0 \pm .30^{a}$	76.5 ± 3.5^{c}
	O	133.9 ± 1.5^{b}	129.6 ± 1.5^{c}	125.0 ± 2.3^{d}	110.7 ± 4.9^{e}
	P	138.6 ± 4.4^{b}	136.4 ± 3.5^{b}	$133.3 \pm .90^{c}$	100.8 ± 0.3^{a}
	A	175.4 ± 6.4^{b}	163.3 ± 4.9^{c}	$143.6 \pm .20^{d}$	112.5 ± 4.4^{e}
M. charantia	B	154.5 ± 1.3^{b}	149.9 ± 4.3^{b}	103.2 ± 2.0^{a}	101.3 ± 3.6^{a}
	O	163.6 ± 3.3^{b}	123.3 ± 1.7^{c}	113.9 ± 5.0^{c}	92.6 ± 1.3^{d}
	P	168.1 ± 5.9^{b}	127.3 ± 3.3^{c}	102.0 ± 3.3^{a}	91.9 ± 0.33^{c}
	A	156.5 ± 2.3^{b}	149.5 ± 4.0^{c}	113.0 ± 2.0^{d}	112.9 ± 1.3^{d}
S. melongena	B	$183.2 \pm .21^{b}$	130.9 ± 1.9^{c}	118.6 ± 2.4^{d}	$107.5 \pm .64^{e}$
	O	$172.7 \pm .42^{b}$	120.8 ± 3.0^{c}	119.0 ± 1.7^{d}	110.0 ± 1.3^{c}
	P	173.0 ± 1.9^{b}	157.6 ± 2.8^{c}	111.0 ± 3.6^{d}	110.4 ± 1.1^{d}
	A	174.4 ± 4.3^{b}	$167.6 \pm .42^{c}$	118.9 ± 2.4^{d}	$108.6 \pm .42^{d}$
T. cucumerina	B	232.2 ± 4.9^{b}	162.7 ± 1.4^{c}	133.8 ± 1.6^{d}	98.7 ± 1.2^{a}
	O	178.2 ± 3.8^{b}	166.0 ± 2.6^{c}	134.8 ± 4.7^{d}	88.7 ± 3.5^{e}
	P	241.5 ± 3.8^{b}	188.2 ± 2.3^{c}	140.9 ± 3.1^{d}	$62.9 \pm .23^{e}$
	A	$223.5 \pm .93^{b}$	163.8 ± 1.9^{c}	$130.4 \pm .23^{d}$	118.2 ± 1.6^{e}
T. dioica	B	108.5 ± 2.5^{b}	104.5 ± 2.1^{a}	$98.2 \pm .62^{c}$	90.1 ± 2.5^{d}
	O	$99.2 \pm .37^{a}$	95.5 ± 0.25^{b}	88.9 ± 2.3^{c}	83.5 ± 1.5^{d}
	P	107.2 ± 2.1^{b}	99.0 ± 2.3^{a}	96.5 ± 1.6^{c}	$83.8 \pm .37^{d}$
	A	$121.2 \pm .74^{b}$	106.2 ± 2.3^{a}	96.0 ± 2.6^{c}	86.7 ± 1.5^{d}
V. unguiculata	B	$218.7 \pm .94^{b}$	131.4 ± 3.5^{c}	125.5 ± 2.3^{c}	113.4 ± 2.8^{d}
	O	226.6 ± 3.7^{b}	165.3 ± 1.4^{c}	152.3 ± 1.9^{d}	137.5 ± 2.6^{e}
	P	147.4 ± 2.1^{b}	136.0 ± 3.7^{c}	$116.2 \pm .23^{d}$	106.5 ± 2.3^{d}
	A	199.4 ± 4.0^{b}	146.2 ± 1.9^{c}	136.1 ± 2.8^{c}	$130.7 \pm .47^{d}$

B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$) where Control = 100^{a}.

Table 07: Percentage (%) of DPPH free radical scavenging activity of fruity vegetables cooked at different methods with different time duration.

Vegetables↓	(%) of DPPH scavenging at .67 mg dv/mL					
	Uncooked	Cooking method	Time in mins			
			2	5	10	20
A. esculentus	27.8 ± .37^{a}	B	48.5 ± 1.1^{b}	33.2 ± .65^{c}	27.8 ± .74^{a}	19.9 ± .19^{d}
		O	45.9 ± .49^{b}	43.1 ± 1.4^{c}	25.7 ± 1.1^{a}	18.8 ±.54^{d}
		P	52.2 ± .37^{b}	42.1 ± 1.1^{c}	39.1 ± .55^{d}	23.6 ± .13^{e}
		A	44.2 ± .54^{b}	39.6 ± .14^{c}	26.7 ± .11^{a}	24.7 ± .34^{d}
C. mixta	10 ± .27^{a}	B	27.1 ± .50^{b}	13.2 ± 1.3^{a}	9.8 ± .11^{a}	8.5 ± .03^{a}
		O	30.7 ± .15^{b}	9.4 ± .15^{c}	7.7 ± .01^{c}	4.2 ± .29^{d}
		P	28.0 ± .83^{b}	7.8 ± .26^{c}	6.7 ± .15^{d}	6.1 ± .26^{e}
		A	33.8 ± .57^{b}	9.2 ± .02^{a}	8.2 ± .02^{a}	7.9 ± .20^{c}
C. dipsaceus	42.3 ± .67^{a}	B	44.8 ± 1.1^{a}	41.5 ± .41^{a}	30.7 ± .85^{c}	12.1 ± .29^{d}
		O	51.4 ± .71^{b}	42.0 ± .41^{a}	29.1 ± .92^{c}	11.0 ± .25^{d}
		P	42.0± .40^{a}	35.0 ± .43^{b}	31.6 ± .15^{c}	8.2 ± .31^{d}
		A	41.4 ± 1.1^{a}	38.0 ± .75^{b}	29.1 ± .18^{c}	11.2 ± .42^{d}
F. hispida	34 ± 1.06^{a}	B	42.5 ± .55^{b}	36.7 ± 1.6^{c}	25.9± .69^{d}	25.8 ± .12^{d}
		O	54.0 ± 1.3^{b}	30.3 ± .80^{c}	29.1 ± .27^{c}	24.1 ± .68^{d}
		P	56.1 ± 1.0^{b}	34.5 ± .16^{c}	33.2 ± .16^{d}	21.3 ± .40^{e}
		A	35.0 ± .12^{b}	32.4 ± .07^{a}	30.1 ± .71^{a}	17.2 ± .12^{c}
L. purpureus	47.7 ± .6^{a}	B	68.6 ± .48^{b}	48.6 ± .31^{a}	45.9 ± 1.5^{c}	31.4 ± .93^{d}
		O	69.3 ± 1.0^{b}	50.1 ± .77^{c}	46.6 ± .48^{d}	25.1 ± .34^{e}
		P	69.7 ± 1.0^{b}	48.3 ± .10^{a}	47.8 ± .76^{a}	29.4 ± .94^{c}
		A	69.5 ± 1.3^{b}	47.2 ± .68^{a}	45.2 ± .45^{a}	31.8 ± 2.4^{d}
L. siceraria	41.8 ± .16^{a}	B	67.1 ± .89^{b}	48.7 ± .97^{c}	44.4 ± .08^{d}	42.0 ± .48^{a}
		O	73.3 ± .30^{b}	46.3 ± .36^{ac}	44.1 ± .54^{d}	43.8 ± .09^{c}
		P	63.6 ± .76^{b}	51.3 ± .44^{c}	43.1 ± .17^{d}	37.4 ± .07^{e}
		A	66.0 ± .85^{b}	45.1 ± .26^{c}	44.5 ± .18^{d}	42.5 ± .57^{c}
L. acutangula	38.2 ± .5^{a}	B	61.9 ± 1.2^{b}	49.3 ± .74^{c}	40.3 ± .08^{d}	14.1 ± .72^{e}
		O	66.0 ± .62^{b}	58.8 ± 1.3^{c}	39.1 ± .81^{d}	21.0 ± .71^{e}
		P	63.6 ± .37^{b}	57.7 ± .89^{c}	39.6 ± 1.2^{d}	18.4 ± .25^{e}
		A	64.6 ± .59^{b}	50.7 ± .79^{c}	38.8 ± .80^{a}	21.5 ± .09^{d}
L. aegyptiaca	33.3 ± .11^{a}	B	45.6 ± .54^{b}	29.4 ± .52^{c}	24.2 ± .56^{d}	16.1 ± .17^{e}
		O	42.6 ±.48^{b}	35.5 ± .38^{c}	22.8 ± .52^{d}	15.1 ± .12^{e}
		P	50.1 ± 1.2^{b}	33.0 ± .56^{a}	31.1 ± .05^{c}	21.5 ± .45^{d}
		A	53.8 ± 1.1^{b}	37.3 ± .14^{c}	28.6 ± .12^{d}	24.8 ± .43^{e}
M. charantia	27.3 ± .13^{a}	B	36.9 ± .69^{b}	27.9 ± 1.2^{c}	18.4 ± .03^{d}	9.0 ± .13^{c}
		O	37.4 ± .38^{b}	21.5 ± .16^{c}	19.7 ± .03^{d}	15.9 ± .13^{e}
		P	40.4 ± .29^{b}	32.7 ± .53^{c}	25.8 ± .40^{a}	21.1 ± .73^{d}
		A	49.0 ± .31^{b}	23.9 ± .14^{c}	21.1 ± .73^{d}	20.8 ± .18^{e}
S. melongena	43 ± .08^{a}	B	67.9 ± .23^{b}	52.4 ± .48^{c}	42.2 ± .24^{a}	6.2 ± .27^{d}
		O	67.0 ± .88^{b}	51.5 ± .92^{c}	42.1 ± .40^{a}	6.1 ± .04^{d}
		P	66.7 ± .87^{b}	59.5 ± .96^{c}	41.6 ± .32^{d}	6.7 ± .10^{e}
		A	68.6 ± .71^{b}	53.0 ± 1.2^{c}	35.9 ± .81^{d}	16.7 ± .25^{e}
T. cucumerina	42 ± .41^{a}	B	60.3 ± 1.6^{b}	23.3 ± .32^{c}	20.5 ± .45^{d}	19.7 ± .36^{d}
		O	57.2 ± .46^{b}	22.8 ± .10^{c}	21.1 ± 1.1^{d}	15.5 ± .02^{e}
		P	61.2 ± 1.8^{b}	30.6 ± .62^{c}	28.3 ± .26^{d}	23.4 ± .42^{e}
		A	65.8 ± .66^{b}	26.9 ± .10^{c}	25.2 ± .15^{d}	20.0 ± .32^{e}
T. dioica	20 ± .58^{a}	B	71.2 ± .54^{b}	33.7 ± 1.0^{c}	19.0 ± .75^{a}	1.5 ± .05^{d}
		O	70.6 ± 1.1^{b}	31.2 ± .10^{c}	19.1 ± 1.2^{a}	2.4 ± .07^{d}
		P	72.6 ± .87^{b}	25.4 ± .18^{c}	17.5 ± .05^{a}	2.2 ± .10^{d}
		A	71.3 ± 1.1^{b}	29.6 ± .77^{c}	18.3± .34^{a}	3.4 ± .22^{d}
V. unguiculata	36 ± .71^{a}	B	49.7 ± .56^{b}	32.5 ± .42^{c}	28.9 ± .78^{d}	19.8 ± .88^{e}
		O	45.9 ± 1.2^{b}	27.6 ± 1.3^{c}	19.5 ± .39^{d}	18.4 ± .49^{e}
		P	48.2 ± .84^{b}	32.9 ± .34^{c}	23.7 ± .30^{d}	14.3 ± .09^{e}
		A	41.6 ± .73^{b}	29.3 ± 1.2^{c}	26.0 ± .11^{d}	20.0 ± .91^{e}

B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$).

Table 08: Percentage (%) of change of DPPH free radical scavenging activity (%) of fruity vegetables cooked at different cooking methods with different time duration.

Vegetables↓	(%) of DPPH scavenging at .67 mg dv/mL				
	Cooking method	Time in mins			
		2 (%)	5 (%)	10 (%)	20 (%)
A. esculentus	B	174.6 ± 3.8 ^{b}	119.6 ± 2.3 ^{c}	100.1 ± 2.7 ^{a}	71.5 ± 0.7 ^{d}
	O	165.4 ± 1.7 ^{b}	155.4 ± 5.1 ^{c}	92.5 ± 4.0 ^{a}	67.7 ± 2.0 ^{d}
	P	187.8 ± 1.3 ^{b}	151.8 ± 4.0 ^{c}	140.8 ± 2.0 ^{d}	85.2 ± 0.5 ^{e}
	A	159.4 ± 1.9 ^{b}	142.5 ± 0.5 ^{c}	96.3 ± 0.4 ^{a}	87.8 ± 1.2 ^{d}
C. mixta	B	217.1± 5.0 ^{b}	131.6 ± 1.3 ^{a}	96.4 ± 1.1 ^{a}	84.9 ± 0.3 ^{a}
	O	305.7 ± 1.5 ^{b}	93.9 ± 1.5 ^{c}	77.0 ± .09 ^{c}	41.5 ± 2.9 ^{d}
	P	279.6 ± 8.3 ^{b}	77.4 ± 2.6 ^{c}	66.7 ± 1.5 ^{d}	60.7 ± .63 ^{e}
	A	336.6 ± 5.7 ^{b}	91.3 ± 0.2 ^{a}	81.3 ± .22 ^{a}	74.6 ± 1.9 ^{c}
C. dipsaceus	B	105.8 ± 2.6 ^{a}	98.1 ± 1.0 ^{a}	72.5 ± 2.0 ^{c}	28.6 ± 0.7 ^{d}
	O	121.4 ± 1.6 ^{b}	99.2 ± 1.0 ^{a}	68.6 ± 0.4 ^{c}	26.0 ± 0.6 ^{d}
	P	99.0 ± 0.9 ^{a}	82.6 ± 1.0 ^{b}	74.7 ± 0 .3 ^{c}	19.4 ± 0.7 ^{d}
	A	97.7 ± 2.5 ^{a}	89.5 ± 1.8 ^{b}	68.6 ± 0.4 ^{c}	26.4 ± 1.0 ^{d}
F. hispida	B	125.2 ± 1.6 ^{b}	108 ± 4.8 ^{c}	76.3 ± 2.0 ^{d}	76.3 ± 3.0 ^{d}
	O	159.0 ± 3.7 ^{b}	89.2 ± 2.2 ^{c}	85.8 ± 0.8 ^{c}	71.0 ± 2.0 ^{d}
	P	165.3 ± 2.8 ^{b}	101.7 ± 0.5 ^{c}	97.8 ± 0.5 ^{d}	62.9 ± 1.2 ^{e}
	A	103.2 ± 0.3 ^{b}	95.5 ± 0.2 ^{a}	88.7 ± 2.1 ^{a}	50.7 ± 0.3 ^{c}
L. purpureus	B	143.7 ± 1.0 ^{b}	101.7 ± 0.6 ^{a}	96.1 ± 3.1 ^{c}	65.8 ± 1.9 ^{d}
	O	145.2 ± 2.1 ^{b}	105 ± 1.6 c	97.0 ± 1.0 ^{d}	52.5 ± 0.7 ^{e}
	P	146.0 ± 2.1 ^{b}	101.1 ± 0.2 ^{a}	100.0 ± 1.6 ^{a}	61.6 ± 2.0 ^{c}
	A	145.7 ± 2.7 ^{b}	98.8 ± 1.4 ^{a}	94.6 ± 0.9 ^{a}	66.6 ± 5.1 ^{d}
L. siceraria	B	160.5 ± 2.1 ^{b}	116.5 ± 2.3 ^{c}	106.1 ± 0.2 ^{d}	100.5 ± 1.1 ^{a}
	O	175.3 ± 0.7 ^{b}	110.7 ± 0.9 ^{ac}	105.6 ± 1.3 ^{d}	104.8 ± 0.2 ^{c}
	P	152.0 ± 1.8 ^{b}	122.6 ± 1.1 ^{c}	103.1 ± 0.4 ^{d}	89.8 ± 0.2 ^{e}
	A	157.9 ± 2.0 ^{b}	107.9 ± 0.6 ^{c}	106.5 ± 0.4 ^{d}	101.6 ± 1.4 ^{e}
L. acutangula	B	162.2± 3.2 ^{b}	129.1 ± 2.0 ^{c}	105.5 ± 0.2 ^{d}	37.0 ± 1.9 ^{e}
	O	172.9 ± 1.6 ^{b}	153.9 ± 3.3 ^{c}	102.5 ± 2.1 ^{d}	54.8 ± 1.9 ^{e}
	P	166.6 ± 1.0 ^{b}	151.1 ± 2.3 ^{c}	103.8 ± 3.2 ^{d}	48.2 ± 0.7 ^{e}
	A	169.2 ± 1.5 ^{b}	132.9 ± 2.1 ^{c}	101.7 ± 2.1 ^{a}	56.3 ± 0.2 ^{d}
L. aegyptiaca	B	137.0 ± 1.6 ^{b}	88.4 ± 1.7 ^{c}	72.8 ± 1.7 ^{d}	48.2 ± 0.5 ^{e}
	O	127.9 ± 1.4 ^{b}	106.6 ± 1.1 ^{c}	68.6 ± 1.6 ^{d}	45.2 ± 0.3 ^{e}
	P	150.6 ± 3.5 ^{b}	99.0 ± 1.7 ^{a}	93.3 ± 0.1 ^{c}	64.6 ± 1.3 ^{d}
	A	161.7 ± 3.4 ^{b}	112.1 ±0.4 ^{c}	86.1 ± 0.3 ^{d}	74.5 ± 1.3 ^{e}
M. charantia	B	135.2 ± 2.5 ^{b}	102.0 ± 4.5 ^{c}	67.3 ± 0.1 ^{d}	32.9 ± 0.5 ^{e}
	O	136.8 ± 1.4 ^{b}	78.6 ± 0.6 ^{c}	72.3 ± 0.1 ^{d}	58.1 ± 0.5 ^{e}
	P	147.8 ± 1.1 ^{b}	119.7 ± 1.9 ^{c}	94.3 ± 1.5 ^{a}	77.1 ± 2.7 ^{d}
	A	179.2 ± 1.1 ^{b}	87.7 ± 0.5 ^{c}	78.7 ± 0.3 ^{d}	76.0 ± 0.7 ^{e}
S. melongena	B	157.8 ± .50 ^{b}	121.9 ± 1.1 ^{c}	98.2 ± 0.6 ^{a}	14.4 ± 0.6 ^{d}
	O	155.9 ± 2.1 ^{b}	119.8 ± 2.1 ^{c}	97.8 ± 0.9 ^{a}	14.3 ± 0.1 ^{d}
	P	155.2 ± 2.0 ^{b}	138.5 ± 2.2 ^{c}	96.7 ± 0.7 ^{d}	15.5 ± 0.2 ^{e}
	A	159.4 ± 1.7 ^{b}	123.1 ± 2.8 ^{c}	83.4 ± 1.9 ^{d}	38.8 ± 0.2 ^{e}
T. cucumerina	B	143.8 ± 3.7 ^{b}	55.5 ± 0.8 ^{c}	48.8 ± 1.1 ^{d}	47.0 ± 0.9 ^{d}
	O	136.5 ± 1.1 ^{b}	54.3 ± 0.2 ^{c}	50.2 ± 2.6 ^{d}	36.9 ± .04 ^{e}
	P	146.0 ± 4.3 ^{b}	72.9 ± 1.5 ^{c}	67.4 ± 0.6 ^{d}	55.7 ± 0.1 ^{e}
	A	157.0 ± 1.6 ^{b}	64.1 ± 0.2 ^{c}	60.1 ± .34 ^{d}	47.7 ± 0.8 ^{e}
T. dioica	B	355.4 ± 2.7 ^{b}	168.1 ± 5.2 ^{c}	94.8 ± 3.8 ^{a}	7.7 ± 0.3 ^{d}
	O	352.3 ± 5.2 ^{b}	155.5 ± 0.5 ^{c}	95.2 ± 5.9 ^{a}	11.7 ± 0.4 ^{d}
	P	362.3 ± 4.3 ^{b}	126.5 ± 0.9 ^{c}	87.4 ± 0.2 ^{a}	10.9 ± 0.5 ^{d}
	A	355.8 ± 5.4 ^{b}	147.5 ± 3.8 ^{c}	91.5 ± 1.7 ^{a}	17.0 ± 1.1 ^{d}
V. unguiculata	B	138.1 ± 1.6 ^{b}	90.2 ± 1.2 ^{c}	80.3 ± 2.1 ^{d}	55.1 ± 2.4 ^{e}
	O	127.5 ± 3.5 ^{b}	76.8 ± 3.5 ^{c}	54.3 ± 1.1 ^{d}	51.0 ± 1.4 ^{e}
	P	134.1 ± 2.3 ^{b}	91.5 ± 0.9 ^{c}	65.9 ± 0.8 ^{d}	39.8 ± 0.3 ^{e}
	A	115.7 ± 2.0 ^{b}	81.3 ± 3.3 ^{c}	72.1 ± 0.3 ^{d}	55.6 ± 2.5 ^{e}

B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$) where Control = 100^{a}.

Table 09: Reducing power of fruity vegetables cooked at different methods with different time duration

Vegetables↓	Reducing power (OD) at .8 mg dv/mL					
	Uncooked	Cooking method	Time in mins			
			2	5	10	20
A. esculentus	.41 ± .001 [a]	B	.79 ± .007 [b]	.51 ± .016 [c]	.48 ± .001 [d]	.48 ± .003 [d]
		O	.78 ± .003 [b]	.76 ± 0.05 [b]	.64 ± .012 [c]	.54 ±.029 [d]
		P	.81 ± .015 [b]	.60 ± .018 [c]	.57 ± .012 [d]	.55 ± .006 [e]
		A	.80 ± .003 [b]	.77 ± .005 [c]	.55 ± .001 [d]	.51 ± .009 [e]
C. mixta	.515 ± .139 [a]	B	.67 ± .018 [b]	.56 ± .001 [c]	.39 ± .008 [d]	.35 ± .003 [e]
		O	.72 ± 0.01 [b]	.57 ± .004 [c]	.35 ± .002 [d]	.34 ± .012 [d]
		P	.67 ± 0.01 [b]	.53 ± .005 [a]	.37 ± .026 [c]	.35 ± .015 [c]
		A	.75 ± .001 [b]	.53 ± .001 [c]	.35 ± .007 [d]	.35 ± .004 [d]
C. dipsaceus	.461 ±.003 [a]	B	.64 ± .008 [b]	.63 ± .002 [c]	.58 ± .002 [d]	.46 ± .002 [a]
		O	.69 ± .003 [b]	.65 ± .012 [c]	.58 ± .003 [d]	.45 ± .003 [e]
		P	.70 ± .008 [b]	.60 ± .011 [c]	.59 ± .016 [d]	.42 ± 0.01 [e]
		A	.67 ± .005 [b]	.62 ± .002 [c]	.60 ± .003 [d]	.48 ± .003 [e]
F. hispida	.544 ± .033 [a]	B	.89 ± .002 [b]	.57 ± .006 [a]	.53 ± .005 [a]	.45 ± .022 [c]
		O	.81 ± .007 [b]	.53 ± .002 [a]	.51 ± .004 [a]	.44 ± .032 [c]
		P	.91 ± .03 [b]	.77 ± .001 [c]	.72 ± .002 [d]	.49 ± .015 [e]
		A	1.0 ± .058 [b]	.89 ± .019 [c]	.72 ± .007 [c]	.37 ± .002 [d]
L. purpureus	.547 ±.005 [a]	B	1.1 ± .053 [b]	1.1 ± .021 [c]	.72 ± 0.01 [d]	.59 ± .007 [a]
		O	1.1 ± .001 [b]	1.0 ± .005 [c]	.78 ± 0.02 [d]	.57 ± .003 [e]
		P	.95 ± .016 [b]	.84 ± .006 [c]	.72 ± .008 [d]	.61 ± .007 [e]
		A	1.0 ± .014 [b]	.86 ± .016 [c]	.84± .02 [d]	.53 ± .006 [e]
L. siceraria	.344± .013 [a]	B	1.1 ± .022 [b]	.98 ±.013 [c]	.94 ± .01 [d]	.45 ± 0.01 [e]
		O	.93 ± .008 [b]	.88 ± 0.03 [c]	.82 ± .003 [d]	.42 ± 0.02 [e]
		P	1.0 ± .014 [b]	.85 ± .007 [c]	.79 ± .008 [c]	.47± 0.03 [a]
		A	1.1 ± .011 [b]	.99 ± .015 [bc]	.95 ± .004 [c]	.42 ± .003 [a]
L. acutangula	.644 ± .002 [a]	B	.75 ± .001 [b]	.73 ±.015 [c]	.72 ± 0.02 [c]	.66 ± 0.01 [a]
		O	.76 ± .026 [b]	.74 ± .005 [c]	.68 ± 0.01 [d]	.66 ± 0.01 [a]
		P	.78 ± .001 [b]	.78 ± .013 [b]	.73 ± .005 [c]	.63 ± 0.01 [d]
		A	.90 ± .004 [b]	.75 ± .035 [b]	.75 ± .036 [c]	.72 ± .003 [c]
L. aegyptiaca	.415 ± .002 [a]	B	.71 ± .025 [b]	.55 ± .018 [c]	.44 ± 0.01 [a]	.40 ± .003 [a]
		O	.56 ±.002 [b]	.54 ± .002 [c]	.45 ± .002 [d]	.40 ± .001 [a]
		P	.58 ± 0.01 [b]	.53 ± .003 [c]	.52 ± .013 [c]	.41 ± .003 [a]
		A	.61 ± .004 [b]	.59 ± .011 [c]	.58 ± .007 [c]	.45 ± .005 [d]
M. charantia	.47 ± .005 [a]	B	.62 ± .042 [b]	.57 ± .003 [c]	.50 ± .013 [a]	.46± .001 [a]
		O	.63 ± .003 [b]	.51 ± .002 [c]	.45 ± .005 [d]	.44 ± .001 [d]
		P	.52 ± .014 [b]	.52 ± .003 [b]	.48 ± .003 [a]	.41 ± .005 [c]
		A	.56 ± .014 [b]	.54 ± .017 [c]	.51 ± .002 [d]	.49 ± .002 [e]
S. melongena	.427 ± .003 [a]	B	.74 ± .02 [b]	.69 ± .004 [c]	.53 ± .004 [d]	.36 ± .005 [e]
		O	.79 ± .022 [b]	.69 ± .001 [c]	.55 ± .003 [d]	.32 ± .009 [e]
		P	.70 ± .007 [b]	.60 ± .001 [c]	.51 ± .001 [d]	.32 ± .005 [e]
		A	.69 ± 0.01 [b]	.65 ± .005 [c]	.52 ± .005 [d]	.33 ± .029 [e]
T. cucumerina	.561 ± .003 [a]	B	.94 ± .016 [b]	.64 ± .004 [c]	.57 ± .016 [a]	.43 ± .002 [d]
		O	1.11 ± .004 [b]	.64 ± .016 [c]	.62 ± .006 [d]	.58 ± .002 [e]
		P	1.04 ± .013 [b]	.64 ± .005 [c]	.61 ± .001 [d]	.51 ± 0.01 [e]
		A	1.10 ± .047 [b]	.65 ± .008 [c]	.62 ± .017 [c]	.52 ± .003 [d]
T. dioica	.515 ± .006 [a]	B	.96 ± .003 [b]	.89 ± .029 [c]	.55 ± .007 [d]	.55 ± .004 [d]
		O	.88 ± .008 [b]	.70 ± .006 [c]	.63 ± .002 [d]	.49 ± .006 [e]
		P	.96 ± .036 [b]	.62 ± .003 [c]	.54 ± .001 [d]	.54 ± .007 [ad]
		A	.95 ± .011 [b]	.78 ± .003 [c]	.70 ± .012 [d]	.54 ± .007 [a]
V. unguiculata	.419 ± .017 [a]	B	.72 ± .005 [b]	.58 ± .013 [c]	.53 ± .003 [d]	.42 ± .017 [a]
		O	.74 ± .001 [b]	.59 ± .001 [c]	.52 ± .005 [d]	.48 ± .017 [e]
		P	.72 ± .004 [b]	.61 ± .004 [c]	.42 ± .003 [a]	.35 ± .009 [d]
		A	.74 ±.021 [b]	.62 ± .003 [c]	.53 ± .005 [d]	.40 ± .006 [a]

B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$).

Table 10: Percentage (%) of change of reducing power activity of fruity vegetables cooked at different methods with different time duration.

Vegetables↓	Reducing power (OD) at .8 mg dv/mL				
	Cooking method	Time in mins			
		2 (%)	5 (%)	10 (%)	20 (%)
A. esculentus	B	192.6 ± 1.6 ^{b}	124.8 ± 3.8 ^{c}	117.8 ± .12 ^{d}	116.1 ± .73 ^{d}
	O	191.2 ± 0.7 ^{b}	186.1 ± 12 ^{b}	155.9 ± 2.9 ^{c}	132.6 ± 7.0 ^{d}
	P	196.7 ± 3.5 ^{b}	145.9 ± 4.4 ^{c}	139.3 ± 2.9 ^{d}	133.5 ± 1.3 ^{e}
	A	196.1 ± 0.7 ^{b}	187.8 ± 1.2 ^{c}	133.9 ± .24 ^{d}	123 ± 2.1 ^{c}
C. mixta	B	129.2 ± 3.4 ^{b}	108.6 ± 0.1 ^{c}	75.5 ± 1.6 ^{d}	67.4 ± 0.6 ^{e}
	O	139.7 ± 1.8 ^{b}	110.2 ± 0.7 ^{c}	67.9 ± 0.3 ^{d}	65.0 ± 2.3 ^{d}
	P	129.3 ± 2.1 ^{b}	102.3 ± 0.1 ^{a}	71.3 ± 5.0 ^{c}	67.2 ± 2.9 ^{c}
	A	145.7 ± 0.1 ^{b}	103.3 ± 0.2 ^{c}	68.0 ± 1.4 ^{d}	67.7 ± 0.7 ^{d}
C. dipsaceus	B	138.8 ± 1.6 ^{b}	136.8 ± 0.3 ^{c}	125.3 ± 0.3 ^{d}	98.6 ± 0.3 ^{a}
	O	150.7 ± 0.5 ^{b}	141.8 ± 2.5 ^{c}	124.7 ± 0.7 ^{d}	97.5 ± 0.5 ^{e}
	P	151.3 ± 1.6 ^{b}	126.9 ± 3.5 ^{c}	131.0 ± 2.4 ^{d}	90.0 ± 1.3 ^{e}
	A	145.7 ± 1.0 ^{b}	135.1 ± 0.4 ^{c}	130.2 ± 0.7 ^{d}	103.3 ± 0.7 ^{c}
F. hispida	B	163.6 ± 0.4 ^{b}	105.1 ± 1.1 ^{a}	97.0 ± 0.8 ^{a}	82.0 ± 4.0 ^{c}
	O	149.3 ± 1.3 ^{b}	96.6 ± 0.3 ^{a}	94.3 ± 0.6 ^{a}	80.0 ± 5.8 ^{c}
	P	168.0 ± 5.5 ^{b}	141.2 ± 0.2 ^{c}	131.4 ± 0.4 ^{d}	89.1 ± 2.7 ^{e}
	A	182.4 ± 10.6 ^{b}	163.4 ± 3.5 ^{c}	132.5 ± 1.3 ^{c}	67.6 ± 0.4 ^{d}
L. purpureus	B	207.7 ± 9.7 ^{b}	192.0 ± 3.7 ^{c}	131.4 ± 1.6 ^{d}	107.6 ± 1.2 ^{a}
	O	204.3 ± 1.7 ^{b}	183.4 ± 0.9 ^{c}	142.6 ± 2.7 ^{d}	103.5 ± 0.5 ^{e}
	P	173.1 ± 2.9 ^{b}	153.7 ± 1.0 ^{c}	131.7 ± 1.4 ^{d}	111.5 ± 0.2 ^{e}
	A	179.2 ± 2.6 ^{b}	157.6 ± 2.9 ^{c}	153.9 ± 1.6 ^{d}	96.3 ± 1.0 ^{e}
L. siceraria	B	310.0 ± 6.6 ^{b}	284.7 ± 3.8 ^{c}	272.1 ± 2.8 ^{d}	132.2 ± 2.9 ^{e}
	O	269.1 ± 2.2 ^{b}	254.7 ± 8.7 ^{c}	237.1 ± 0.7 ^{d}	120.7 ± 4.5 ^{e}
	P	287.6 ± 3.9 ^{b}	248.6 ± 7.9 ^{c}	231.1 ± 2.0 ^{c}	137.0 ± 2.2 ^{a}
	A	308.0 ± 3.3 ^{b}	287.5 ± 4.2 ^{bc}	275.8 ± 1.0 ^{c}	120.7 ± 0.7 ^{a}
L. acutangula	B	116.9 ± 0.2 ^{b}	113.3 ± 2.3 ^{c}	111.6 ± 2.6 ^{c}	101.9 ± 0.8 ^{a}
	O	118.1 ± 4.0 ^{b}	114.4 ± 0.7 ^{c}	105.8 ± 1.4 ^{d}	103.0 ± 1.1 ^{a}
	P	121.5 ± 0.1 ^{b}	120.6 ± 2.0 ^{b}	112.8 ± 0.8 ^{c}	98.0 ± 1.4 ^{d}
	A	139.4 ± 0.5 ^{b}	117.0 ± 5.4 ^{b}	116.9 ± 5.5 ^{c}	111.7 ± 0.4 ^{c}
L. aegyptiaca	B	170.0 ± 5.9 ^{b}	131.4 ± 4.2 ^{c}	105.5 ± 1.7 ^{a}	95.1 ± 0.6 ^{a}
	O	135.1 ± 0.4 ^{b}	130.7 ± 0.4 ^{c}	108.5 ± 0.4 ^{d}	95.7 ± 0.2 ^{a}
	P	139.9 ± 2.3 ^{b}	128.7 ± 0.7 ^{c}	125.9 ± 3.0 ^{c}	99.5 ± 0.7 ^{a}
	A	146.4 ± 0.8 ^{b}	142.3 ± 2.5 ^{c}	140.4 ± 1.6 ^{c}	107.8 ± 1.1 ^{d}
M. charantia	B	132.0 ± 8.0 ^{b}	120.7 ± 0.5 ^{c}	105.3 ± 2.7 ^{a}	97.0 ± 0.1 ^{a}
	O	133.3 ± 0.6 ^{b}	108.6 ± 0.4 ^{c}	95.4 ± 1.1 ^{d}	94.7 ± 0.1 ^{d}
	P	110.8 ± 3.0 ^{b}	111.6 ± 0.6 ^{b}	100.9 ± 0.5 ^{a}	86.8 ± 1.0 ^{c}
	A	119.1 ± 0.3 ^{b}	115.1 ± 3.5 ^{c}	108.6 ± 0.4 ^{d}	104.2 ± 0.4 ^{c}
S. melongena	B	172.3 ± 4.2 ^{b}	161.9 ± 0.8 ^{c}	125.0 ± 0.9 ^{d}	84.6 ± 1.2 ^{e}
	O	183.9 ± 5.0 ^{b}	161.0 ± 0.1 ^{c}	128.7 ± 0.7 ^{d}	74.8 ± 2.1 ^{e}
	P	163.1 ± 1.5 ^{b}	139.7 ± 0.2 ^{c}	119.2 ± 0.1 ^{d}	75.7 ± .1.2 ^{e}
	A	161.0 ± 2.2 ^{b}	152.5 ± 1.1 ^{c}	120.8 ± 0.4 ^{d}	77.1 ± 6.8 ^{e}
T. cucumerina	B	167.1 ± 2.8 ^{b}	113.6 ± 0.7 ^{c}	101.0 ± 2.9 ^{a}	76.8 ± 0.3 ^{d}
	O	197.3 ± 0.7 ^{b}	113.6 ± 2.8 ^{c}	110.3 ± 1.1 ^{d}	103.9 ± 0.3 ^{e}
	P	184.8 ± 2.3 ^{b}	113.9 ± 0.8 ^{c}	108.4 ± .09 ^{d}	91.3 ± 1.7 ^{e}
	A	188.6 ± 8.4 ^{b}	115.1 ± 1.4 ^{c}	110.5 ± 2.9 ^{c}	92.5 ± 0.4 ^{d}
T. dioica	B	186.9 ± 0.5 ^{b}	172.7 ± 5.5 ^{c}	105.7 ± 1.3 ^{d}	105.9 ± 0.7 ^{d}
	O	171.5 ± 1.6 ^{b}	135.5 ± 1.2 ^{c}	121.9 ± 0.4 ^{d}	94.7 ± 1.1 ^{e}
	P	186.2 ± 7.0 ^{b}	121.1 ± 0.5 ^{c}	105.6 ± 0.2 ^{d}	104.6 ± 1.3 ^{ad}
	A	183.7 ± 2.1 ^{b}	151.1 ± 0.6 ^{c}	136.2 ± 2.2 ^{d}	104.6 ± 1.3 ^{a}
V. unguiculata	B	172.6 ± 1.2 ^{b}	138.7 ± 3.1 ^{c}	127.3 ± 0.6 ^{d}	100.7 ± 4.1 ^{a}
	O	175.7 ± .12 ^{b}	139.7 ± 0.1 ^{c}	124.3 ± 1.2 ^{d}	114.3 ± 4.1 ^{c}
	P	172.6 ± .84 ^{b}	145.8 ± 1.0 ^{c}	99.8 ± 0.7 ^{a}	84.1 ± 2.0 ^{d}
	A	176.4 ± 5.0 ^{b}	148.7 ± 0.7 ^{c}	126.3 ± 1.2 ^{d}	98.4 ± 1.3 ^{a}

B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by ($p < 0.05$) where Control = 100^{a}.

Table 11: Total Antioxidant capacity (AA) of fruity vegetables cooked at different methods with different time duration.

Vegetables↓			Total Antioxidant activity (mg AAE/g dv)			
	Uncooked	Cooking method	Time in mins			
			2	5	10	20
A. esculentus	44.4 ± 1.7^{a}	B	34.5 ± 2.6^{b}	38.9 ± .64^{b}	43.0 ± 1.0^{a}	37.3 ± .09^{b}
		O	33.0 ± 1.0^{b}	41.5 ± 2.3^{c}	43.1 ± .50^{a}	37.3 ± 1.3^{d}
		P	30.4 ± 1.0^{b}	41.1 ± 2.8^{c}	44.2 ± 1.0^{a}	41.0 ± .27^{c}
		A	36.7 ± 5.1^{b}	43.0 ± 1.2^{c}	46.2 ± .08^{ac}	42.4 ± .33^{a}
C. mixta	79.5 ± 1.2^{a}	B	25.7 ± 2.0^{b}	68.0 ± 2.3^{c}	82.6 ± .45^{d}	24.0 ± 3.7^{b}
		O	33.5 ± 5.7^{b}	63.5 ± .46^{c}	90.2 ± .72^{d}	25.4 ± 1.0^{e}
		P	24.5 ± 2.2^{b}	63.3 ± .65^{c}	81.7 ± 1.0^{a}	28.0 ± 5.4^{d}
		A	31.2 ± 4.0^{b}	66.9 ± 1.3^{c}	93.9 ± .18^{d}	30.1 ± 5.2^{b}
C. dipsaceus	46.0 ± .43^{a}	B	27.7 ± .26^{b}	28.4 ± 2.2^{b}	49.4 ± 1.2^{d}	38.8 ± .81^{d}
		O	26.7 ± .97^{b}	30.7 ± 1.1^{c}	49.2 ± .77^{d}	37.6 ± 1.0^{e}
		P	24.1 ± .09^{b}	29.3 ± .92^{c}	52.7 ± .62^{a}	45.6 ± .90^{d}
		A	22.5 ± 1.2^{b}	34.4 ± .37^{c}	47.3 ± 1.1^{d}	44.8 ± 1.0^{e}
F. hispida	39.4 ± 2.1^{a}	B	25.3 ± .70^{b}	30.3 ± .72^{c}	42.8 ± .53^{d}	25.3 ± 1.6^{b}
		O	22.0 ± .25^{b}	24.7 ± .16^{c}	31.6 ± .18^{d}	26.9 ± .53^{c}
		P	18.5 ± .34^{b}	28.3 ± .72^{c}	35.4 ± 1.5^{d}	29.0 ± .18^{c}
		A	28.4 ± 1.2^{b}	31.4 ± .08^{c}	35.1 ± .44^{c}	33.3 ± .90^{d}
L. purpureus	94.3 ± .72^{a}	B	62.3 ± 1.7^{b}	77.7 ± .87^{c}	84.6 ± 1.3^{d}	74.0 ± 1.6^{e}
		O	66.8 ± .17^{b}	69.2 ± 1.0^{b}	83.4 ± 1.3^{c}	65.9 ± 3.3^{d}
		P	56.6 ± 1.3^{b}	72.4± 2.8^{c}	85.3 ± 3.6^{d}	61.4 ± .53^{e}
		A	57.1 ± .86^{b}	81.5 ± 1.1^{c}	85.4 ± 1.3^{c}	66.1 ± 1.1^{e}
L. siceraria	103.5 ±5.3^{a}	B	62.0 ± 3.5^{b}	78.2 ± 4.4^{c}	113.3 ± 2.4^{d}	64.2 ± 2.8^{b}
		O	62.9 ± 1.7^{b}	94.3 ± 2.0^{a}	114.7 ± 3.4^{c}	64.8 ± 3.6^{b}
		P	56.4 ± .36^{b}	69.6 ± 1.9^{c}	112.1 ± 5.1^{d}	54.0 ± 2.9^{b}
		A	64.2 ± 4.2^{b}	79.3 ± 1.5^{c}	133.5 ± 4.8^{d}	54.5 ± 1.5^{e}
L. acutangula	35.2 ± .34^{a}	B	20.5 ± 2.7^{b}	23.1 ± .80^{c}	34.4 ± 1.1^{a}	30.3 ± .69^{d}
		O	20.0 ± 2.0^{b}	26.2 ± 1.8^{c}	37.7 ± 1.4^{a}	32.7 ± .78^{d}
		P	18.9 ± 1.0^{b}	27.0 ± 1.2^{c}	37.1 ± .26^{d}	35.6 ± .26^{ad}
		A	19.6 ± .52^{b}	36.6 ± 2.7^{a}	41.8 ± 4.3^{c}	33.4 ± 1.2^{a}
L. aegyptiaca	34.6 ± 4.0^{a}	B	22.9 ± .09^{b}	32.0 ± 2.5^{c}	33.8 ± 1.2^{a}	24.9 ± .44^{c}
		O	21.3 ± .80^{b}	28.0 ± 2.1^{c}	37.7 ± 1.7^{a}	32.7 ± .09^{a}
		P	20.7 ± .62^{b}	23.5 ± .27^{c}	36.3 ± 1.7^{a}	27.3 ± 1.0^{d}
		A	22.9 ± 1.2^{b}	26.4 ± 1.5^{c}	37.3 ± .77^{a}	27.6 ± 3.5^{c}
M. charantia	53.6 ± .34^{a}	B	23.9 ± 4.1^{b}	30.9 ± 1.6^{b}	42.6 ± 1.2^{c}	32.1 ± .60^{b}
		O	24.1 ± .17^{b}	28.4 ± .53^{c}	46.5 ± 1.6^{d}	31.9 ± .70^{e}
		P	23.7 ± .43^{b}	27.0 ± 1.5^{c}	47.7 ± 2.4^{d}	29.9 ± 1.4^{c}
		A	28.5 ± 1.0^{b}	30.8 ± .80^{b}	49.4 ± .26^{c}	32.8±2.4^{c}
S. melongena	51.9 ± 4.0^{a}	B	29.1 ± 1.1^{b}	35.1 ± 2.6^{c}	45.1 ± 2.3^{d}	41.1 ± 2.0^{d}
		O	35.3 ± 4.1^{b}	37.5 ± 1.7^{b}	50.9 ± 1.9^{a}	43.3 ± .18^{c}
		P	25.9 ± .61^{b}	36.6 ± 2.0^{c}	48.5 ± 1.9^{d}	40.9 ± 2.6^{c}
		A	31.9 ± 1.0^{b}	52.0 ± 4.6^{ac}	57.0 ± 3.0^{c}	40.6 ± 2.2^{d}
T. cucumerina	138.4 ±1.0^{a}	B	50.6 ± .26^{b}	81.2 ± 2.2^{c}	148.2 ± .71^{d}	63.3 ± 5.2^{e}
		O	77.3 ± 1.7^{b}	83.4 ± .27^{b}	136.5 ± 1.4^{a}	51.3 ± 4.9^{c}
		P	62.7 ± 3.5^{b}	73.1 ± 1.2^{c}	136.0 ± 4.3^{a}	57.1 ± 1.4^{d}
		A	75.2 ± 1.8^{b}	82.0 ± .18^{c}	135.7 ± .90^{d}	53.9 ± 2.3^{e}
T. dioica	60.6 ± 2.6^{a}	B	44.5 ± 3.2^{b}	52.4 ± .53^{c}	61.1 ± 2.6^{a}	53.2 ± 1.7^{c}
		O	40.5 ± 1.4^{b}	41.7 ± .36^{b}	69.8 ± 1.1^{a}	59.8 ± 2.3^{a}
		P	28.0 ± .18^{b}	40.8 ± .36^{c}	64.3 ± 1.2^{d}	62.3 ± .70^{d}
		A	40.2 ± .54^{b}	43.3 ± 1.0^{c}	71.0 ± .81^{d}	64.3 ± .79^{e}
V. unguiculata	39.9 ± 1.2^{a}	B	19.1 ± .61^{b}	25.7 ± 1.6^{c}	31.1 ± .66^{d}	26.6 ± 2.7^{c}
		O	21.7 ± 3.8^{b}	29.6 ± 4.8^{c}	34.0 ± 2.9^{d}	29.7 ± .08^{c}
		P	20.8 ± 1.1^{b}	25.0 ± .94^{c}	35.2 ± .33^{d}	21.8 ± .09^{b}
		A	21.1 ± 2.0^{b}	29.9 ± .86^{c}	38.7 ± .66^{a}	24.5 ± 1.0^{d}

B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$).

Table 12: Percentage (%) of change of Total Antioxidant capacity (AA) of fruity vegetables cooked at different methods with different time duration.

Vegetables↓	Total Antioxidant capacity (mg AAE/g dv)				
	Cooking method	Time in mins			
		2 (%)	5 (%)	10 (%)	20 (%)
A. esculentus	B	77.8 ± 6.0^{b}	87.6 ± 1.4^{b}	96.8 ± 2.3^{a}	$84.0 \pm .20^{b}$
	O	74.3 ± 2.3^{b}	93.6 ± 5.1^{c}	97.2 ± 1.1^{a}	84.1 ± 3.0^{d}
	P	68.5 ± 2.3^{b}	92.7 ± 6.4^{c}	99.5 ± 2.3^{a}	$92.5 \pm .60^{c}$
	A	82.6 ± 11.5^{b}	97.0 ± 2.7^{c}	$104.2 \pm .20^{ac}$	$95.5 \pm .75^{a}$
C. mixta	B	32.3 ± 2.5^{b}	85.5 ± 2.9^{c}	$103.9 \pm .57^{d}$	30.1 ± 4.6^{b}
	O	42.1 ± 7.1^{b}	$79.8 \pm .58^{c}$	$113.4 \pm .91^{d}$	32.0 ± 1.2^{c}
	P	30.8 ± 2.7^{b}	$79.6 \pm .81^{c}$	102.7 ± 1.3^{a}	35.1 ± 6.8^{d}
	A	39.3 ± 5.0^{b}	84.1 ± 1.6^{c}	$118.0 \pm .23^{d}$	37.8 ± 6.5^{b}
C. dipsaceus	B	$60.2 \pm .58^{b}$	61.8 ± 4.8^{b}	107.3 ± 2.6^{d}	84.4 ± 1.8^{d}
	O	58.0 ± 2.1^{b}	66.8 ± 2.4^{c}	106.9 ± 1.7^{d}	81.8 ± 2.1^{c}
	P	$52.4 \pm .19^{b}$	63.9 ± 2.0^{c}	114.6 ± 1.4^{a}	99.2 ± 2.1^{d}
	A	49.0 ± 2.7^{b}	$75.0 \pm .81^{c}$	102.9 ± 2.4^{d}	97.4 ± 2.1^{c}
F. hispida	B	64.2 ± 1.7^{b}	77.0 ± 1.8^{c}	108.6 ± 1.3^{d}	64.2 ± 4.1^{b}
	O	$55.9 \pm .64^{b}$	$62.8 \pm .41^{c}$	$80.3 \pm .45^{d}$	68.2 ± 1.4^{c}
	P	$47.1 \pm .86^{b}$	71.8 ± 1.8^{c}	89.8 ± 3.8^{d}	$73.7 \pm .50^{e}$
	A	72.1 ± 3.0^{b}	$79.8 \pm .21^{c}$	89.0 ± 1.1^{c}	84.7 ± 2.3^{d}
L. purpureus	B	66.7 ± 1.8^{b}	$83.3 \pm .92^{c}$	90.7 ± 1.4^{d}	79.3 ± 1.7^{e}
	O	$71.6 \pm .18^{b}$	74.1 ± 1.1^{b}	89.4 ± 1.4^{c}	70.6 ± 3.5^{d}
	P	60.7 ± 1.4^{b}	77.6 ± 3.0^{c}	91.4 ± 3.8^{d}	$65.9 \pm .56^{e}$
	A	$61.3 \pm .91^{b}$	87.3 ± 1.2^{c}	91.5 ± 1.3^{c}	70.8 ± 1.1^{e}
L. siceraria	B	60.0 ± 3.4^{b}	75.6 ± 4.3^{c}	109.6 ± 2.4^{d}	62.0 ± 2.8^{b}
	O	60.8 ± 1.6^{b}	91.2 ± 2.0^{a}	110.9 ± 3.3^{c}	62.7 ± 3.4^{b}
	P	$54.6 \pm .34^{b}$	67.2 ± 1.8^{c}	108.3 ± 5.0^{d}	53.0 ± 2.9^{b}
	A	62.1 ± 4.1^{b}	76.6 ± 1.5^{c}	113.0 ± 4.6^{d}	52.7 ± 1.5^{e}
L. acutangula	B	58.1 ± 7.6^{b}	65.6 ± 2.2^{c}	97.6 ± 3.2^{a}	86.0 ± 2.0^{d}
	O	56.7 ± 5.7^{b}	74.3 ± 5.2^{c}	106.9 ± 4.0^{a}	92.8 ± 2.2^{d}
	P	53.7 ± 2.7^{b}	76.6 ± 3.5^{c}	$105.8 \pm .75^{d}$	$101.0 \pm .73^{d}$
	A	55.6 ± 1.5^{b}	103.8 ± 7.7^{a}	118.7 ± 12.2^{c}	94.6 ± 2.2^{a}
L. aegyptiaca	B	$66.1 \pm .26^{b}$	92.4 ± 7.2^{c}	97.5 ± 3.5^{a}	71.9 ± 1.3^{c}
	O	61.7 ± 2.3^{b}	81.0 ± 6.1^{c}	108.9 ± 4.8^{a}	$94.4 \pm .25^{a}$
	P	59.8 ± 1.8^{b}	$68.0 \pm .77^{c}$	104.9 ± 5.0^{a}	78.8 ± 2.8^{d}
	A	66.2 ± 3.3^{b}	76.2 ± 4.3^{c}	107.9 ± 2.2^{a}	79.6 ± 10.2^{c}
M. charantia	B	44.6 ± 7.7^{b}	57.6 ± 3.0^{b}	79.6 ± 2.3^{c}	59.8 ± 1.1^{b}
	O	$44.9 \pm .32^{b}$	53.0 ± 1.0^{c}	86.7 ± 3.1^{d}	54 ± 1.3^{c}
	P	$44.1 \pm .81^{b}$	50.4 ± 2.8^{c}	88.8 ± 4.5^{d}	55.8 ± 2.6^{c}
	A	55.2 ± 2.0^{b}	57.4 ± 1.5^{b}	$92.2 \pm .48^{c}$	61.2 ± 4.5^{c}
S. melongena	B	56.1 ± 2.2^{b}	67.6 ± 5.0^{c}	86.8 ± 4.5^{d}	79.1 ± 3.8^{d}
	O	67.9 ± 8.0^{b}	72.3 ± 3.3^{b}	98.1 ± 3.6^{a}	$83.3 \pm .34^{c}$
	P	49.9 ± 1.2^{b}	70.6 ± 3.8^{c}	93.5 ± 3.6^{d}	78.6 ± 5.0^{c}
	A	61.4 ± 1.9^{b}	100.3 ± 8.8^{ac}	110.0 ± 6.1^{c}	78.3 ± 4.3^{d}
T. cucumerina	B	$36.5 \pm .19^{b}$	58.7 ± 1.6^{c}	$107.1 \pm .51^{d}$	45.7 ± 3.7^{e}
	O	55.8 ± 1.2^{b}	60.3 ± 0.2^{b}	98.6 ± 1.0^{a}	37.1 ± 3.5^{c}
	P	45.3 ± 2.5^{b}	$52.8 \pm .85^{c}$	98.3 ± 3.1^{a}	41.3 ± 1.0^{d}
	A	54.3 ± 1.3^{b}	$59.3 \pm .13^{c}$	$98.1 \pm .64^{d}$	38.9 ± 1.7^{e}
T. dioica	B	73.4 ± 5.4^{b}	$86.5 \pm .89^{c}$	100.9 ± 4.4^{a}	87.7 ± 2.8^{c}
	O	66.9 ± 2.2^{b}	$68.8 \pm .60^{b}$	115.1 ± 1.9^{a}	98.7 ± 3.8^{a}
	P	$46.3 \pm .29^{b}$	$67.3 \pm .60^{c}$	106.2 ± 1.9^{d}	102.9 ± 1.2^{d}
	A	$66.4 \pm .90^{b}$	71.5 ± 1.6^{c}	117.2 ± 1.3^{d}	106.2 ± 1.3^{e}
V. unguiculata	B	47.9 ± 1.5^{b}	64.3 ± 3.9^{c}	78.0 ± 1.7^{d}	66.7 ± 6.7^{c}
	O	54.3 ± 9.6^{b}	74.1 ± 12.1^{c}	85.2 ± 7.3^{d}	$74.4 \pm .22^{c}$
	P	52.1 ± 2.8^{b}	62.8 ± 2.4^{c}	$88.2 \pm .83^{d}$	$54.7 \pm .22^{b}$
	A	52.9 ± 4.9^{b}	74.9 ± 2.2^{c}	97.0 ± 1.7^{a}	61.2 ± 2.5^{d}

AA = Ascorbic acid, B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$) where Control = 100^{a}.

Table 13: Total Antioxidant capacity (GA) of fruity vegetables cooked at different methods with different time duration.

Vegetables↓	Total Antioxidant activity (mg GAE/g dv)					
	Uncooked	Cooking method	Time in mins			
			2	5	10	20
A. esculentus	40.5 ± 1.5^{a}	B	30.6 ± 2.3^{b}	$33.5 \pm .55^{b}$	$39.2 \pm .91^{a}$	$31.2 \pm .07^{b}$
		O	$29.2 \pm .91^{b}$	35.8 ± 2.0^{c}	$39.4 \pm .40^{a}$	31.3 ± 1.1^{d}
		P	$26.9 \pm .91^{b}$	35.5 ± 2.4^{c}	$40.3 \pm .91^{a}$	$34.3 \pm .22^{c}$
		A	32.5 ± 4.5^{b}	37.1 ± 1.0^{c}	$38.7 \pm .30^{ac}$	$38.7 \pm .07^{a}$
C. mixta	69.8 ± 1.0^{a}	B	22.4 ± 1.7^{b}	57.3 ± 1.9^{c}	$72.5 \pm .40^{d}$	19.7 ± 3.0^{b}
		O	29.1 ± 4.9^{b}	$53.4 \pm .39^{c}$	73.5 ± 2.3^{d}	$20.9 \pm .80^{e}$
		P	21.4 ± 1.9^{b}	$53.3 \pm .54^{c}$	$71.7 \pm .87^{a}$	22.9 ± 4.4^{d}
		A	27.2 ± 3.5^{b}	56.3 ± 1.1^{c}	$82.3 \pm .16^{d}$	24.7 ± 4.3^{b}
C. dipsaceus	$39.3 \pm .37^{a}$	B	$23.9 \pm .23^{b}$	25.9 ± 1.9^{b}	42.1 ± 1.0^{c}	$32.9 \pm .68^{d}$
		O	$23.0 \pm .84^{b}$	$25.9 \pm .94^{c}$	$42.0 \pm .66^{d}$	$31.8 \pm .83^{e}$
		P	$20.8 \pm .08^{b}$	$24.8 \pm .78^{c}$	$44.6 \pm .53^{a}$	$39.0 \pm .80^{d}$
		A	19.5 ± 1.1^{b}	$29.1 \pm .31^{c}$	$40.4 \pm .95^{d}$	$37.9 \pm .83^{e}$
F. hispida	34.9 ± 1.9^{a}	B	$23.6 \pm .63^{b}$	$27.8 \pm .66^{c}$	$37.9 \pm .47^{d}$	21.7 ± 1.4^{b}
		O	$20.5 \pm .23^{b}$	$22.6 \pm .15^{c}$	$28.0 \pm .16^{d}$	$23.1 \pm .46^{c}$
		P	$17.3 \pm .31^{b}$	$25.9 \pm .67^{c}$	31.3 ± 1.3^{d}	$24.9 \pm .15^{e}$
		A	26.5 ± 1.1^{b}	$28.7 \pm .07^{c}$	$31.1 \pm .40^{c}$	$28.7 \pm .77^{d}$
L. purpureus	$84.6 \pm .64^{a}$	B	54.1 ± 1.5^{b}	$66.8 \pm .75^{c}$	75.9 ± 1.2^{d}	61.9 ± 1.3^{e}
		O	$58.1 \pm .15^{b}$	$59.4 \pm .90^{b}$	74.9 ± 1.2^{c}	55.1 ± 2.7^{d}
		P	49.2 ± 1.1^{b}	62.3 ± 2.4^{c}	76.5 ± 3.2^{d}	$51.4 \pm .44^{e}$
		A	$49.7 \pm .74^{b}$	$70.0 \pm .97^{c}$	76.6 ± 1.1^{c}	$55.3 \pm .89^{e}$
L. siceraria	81.2 ± 4.2^{a}	B	52.6 ± 3.0^{b}	67.3 ± 3.8^{c}	88.9 ± 1.9^{d}	56.5 ± 2.5^{b}
		O	53.4 ± 1.4^{b}	81.3 ± 1.8^{a}	90.0 ± 2.7^{c}	57.0 ± 3.1^{b}
		P	$47.9 \pm .30^{b}$	59.9 ± 1.6^{c}	87.9 ± 4.0^{d}	48.2 ± 2.6^{b}
		A	54.5 ± 3.5^{b}	68.3 ± 1.3^{c}	104.7 ± 3.7^{d}	48.0 ± 1.3^{e}
L. acutangula	$31.3 \pm .3^{a}$	B	17.8 ± 2.3^{b}	$19.7 \pm .68^{c}$	$30.1 \pm .10^{a}$	$26.9 \pm .61^{d}$
		O	17.4 ± 1.7^{b}	22.4 ± 1.6^{c}	33.0 ± 1.2^{a}	$29.0 \pm .70^{d}$
		P	$16.5 \pm .83^{b}$	23.1 ± 1.0^{c}	$32.5 \pm .23^{d}$	$31.6 \pm .23^{ad}$
		A	$17.1 \pm .45^{b}$	31.3 ± 2.3^{a}	36.6 ± 3.8^{c}	29.6 ± 1.1^{a}
L. aegyptiaca	30.1 ± 3.5^{a}	B	$20.1 \pm .08^{b}$	28.5 ± 2.2^{c}	29.4 ± 1.0^{a}	$21.5 \pm .38^{c}$
		O	$19.0 \pm .71^{b}$	24.6 ± 1.9^{c}	$28.4 \pm .07^{a}$	32.5 ± 1.4^{a}
		P	$18.4 \pm .55^{b}$	$20.6 \pm .23^{c}$	31.6 ± 1.5^{a}	$23.6 \pm .83^{d}$
		A	20.4 ± 1.0^{b}	23.1 ± 1.3^{c}	$32.5 \pm .67^{a}$	23.8 ± 3.0^{c}
M. charantia	$43.6 \pm .28^{a}$	B	27.1 ± 3.6^{b}	28.2 ± 1.5^{b}	34.7 ± 1.0^{c}	$28.0 \pm .53^{b}$
		O	$21.1 \pm .15^{b}$	$26.0 \pm .50^{c}$	37.8 ± 1.3^{d}	$25.3 \pm .61^{e}$
		P	$20.8 \pm .38^{b}$	24.7 ± 1.4^{c}	38.8 ± 2.0^{d}	24.4 ± 1.2^{c}
		A	$25.0 \pm .92^{b}$	$26.3 \pm .73^{b}$	$40.2 \pm .21^{c}$	28.7 ± 2.1^{c}
S. melongena	43.8 ± 3.4^{a}	B	26.0 ± 1.0^{b}	30.7 ± 2.3^{c}	38.0 ± 2.0^{d}	35.2 ± 1.7^{d}
		O	31.5 ± 3.7^{b}	32.8 ± 1.5^{b}	43.0 ± 1.6^{a}	$37.1 \pm .15^{c}$
		P	$23.1 \pm .55^{b}$	32.0 ± 1.7^{c}	35.0 ± 2.2^{c}	32.5 ± 1.6^{c}
		A	$28.5 \pm .86^{b}$	45.5 ± 4.0^{ac}	48.1 ± 2.7^{c}	34.9 ± 1.9^{d}
T. cucumerina	$114.2 \pm .8^{a}$	B	$46.2 \pm .24^{b}$	67.1 ± 1.8^{c}	$122.3 \pm .59^{d}$	51.3 ± 4.2^{e}
		O	$68.9 \pm .23^{b}$	70.7 ± 1.5^{b}	112.7 ± 1.2^{a}	41.6 ± 4.0^{c}
		P	57.3 ± 3.2^{b}	$60.3 \pm .10^{c}$	112.3 ± 3.5^{a}	46.3 ± 1.1^{d}
		A	$59.5 \pm .15^{b}$	68.7 ± 1.7^{c}	$112.0 \pm .74$	43.7 ± 1.9^{e}
T. dioica	56.9 ± 2.4^{a}	B	37.0 ± 2.7^{b}	$44.8 \pm .46^{c}$	57.4 ± 2.5^{a}	44.5 ± 1.4^{c}
		O	33.7 ± 1.1^{b}	$35.6 \pm .30^{b}$	56.1 ± 1.1^{a}	50.1 ± 1.9^{a}
		P	$23.3 \pm .15^{b}$	$34.8 \pm .30^{c}$	$58.5 \pm .66^{d}$	53.9 ± 1.0^{d}
		A	$33.4 \pm .45^{b}$	$38.4 \pm .84^{c}$	$60.4 \pm .75^{d}$	$59.4 \pm .67^{e}$
V. unguiculata	39.0 ± 1.1^{a}	B	$16.5 \pm .53^{b}$	22.9 ± 1.4^{c}	$30.3 \pm .65^{d}$	22.6 ± 2.3^{c}
		O	18.7 ± 3.3^{b}	26.4 ± 4.3^{c}	33.2 ± 2.8^{d}	$25.2 \pm .08^{c}$
		P	18.0 ± 1.0^{b}	$22.3 \pm .84^{c}$	$34.3 \pm .32^{d}$	$18.6 \pm .08^{b}$
		A	18.2 ± 1.7^{b}	$26.7 \pm .77^{c}$	$37.8 \pm .65^{a}$	$20.8 \pm .83^{d}$

GA = Gallic acid, B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$).

Table 14: Percentage (%) of change of Total Antioxidant capacity (GA) of fruity vegetables cooked at different methods with different time duration.

Vegetables↓	Total Antioxidant activity (mg GAE/g dv)				
	Cooking method	Time in mins			
		2 (%)	5 (%)	10 (%)	20 (%)
A. esculentus	B	75.6 ± 5.8^{b}	82.8 ± 1.4^{b}	96.9 ± 2.3^{a}	77.0 ± .18^{b}
	O	72.1 ± 2.2^{b}	88.5 ± 4.9^{c}	97.2 ± 1.1^{a}	77.2 ± 2.8^{d}
	P	66.5 ± 2.2^{b}	87.6 ± 6.1^{c}	100.0 ± 2^{a}	84.8 ± .55^{c}
	A	80.2 ± 11.2^{b}	91.6 ± .25^{c}	95.6 ± .75^{ac}	95.5 ± .18^{a}
C. mixta	B	32.1 ± 2.5^{b}	82.1 ± 2.8^{c}	103.9 ± .60^{d}	28.2 ± 4.3^{b}
	O	41.8 ± 7.1^{b}	76.6 ± .54^{c}	105.5 ± 3.3^{d}	29.9 ± 1.2^{e}
	P	30.6 ± 2.7^{b}	76.4 ± .77^{c}	102.8 ± 1.3^{a}	32.9 ± 6.3^{d}
	A	39.0 ± 5.0^{b}	80.7 ± 1.5^{c}	118.1 ± .23^{d}	35.4 ± 6.1^{b}
C. dipsaceus	B	60.9 ± .60^{b}	66.0 ± 4.8^{b}	107.3 ± 2.6^{d}	83.6 ± 4.0^{d}
	O	58.6 ± 2.1^{b}	66.0 ± 2.4^{c}	106.9 ± 1.7^{d}	81.0 ± 2.1^{e}
	P	53.0 ± .20^{b}	63.0 ± 2.0^{c}	113.5 ± 1.4^{a}	99.2 ± 2.0^{d}
	A	49.6 ± 2.7^{b}	73.9 ± .80^{c}	102.9 ± 2.4^{d}	96.4 ± 2.1^{e}
F. hispida	B	67.6 ± 1.8^{b}	79.5 ± 1.9^{c}	108.6 ± 1.4^{d}	62.3 ± 4.0^{b}
	O	58.9 ± .70^{b}	64.9 ± .40^{c}	80.3 ± .44^{d}	66.2 ± 1.3^{c}
	P	49.5 ± .90^{b}	74.2 ± 1.9^{c}	89.9 ± 3.8^{d}	71.5 ± .44^{e}
	A	75.9 ± 3.2^{b}	82.4 ± .21^{c}	89.0 ± 1.1^{c}	82.1 ± 2.2^{d}
L. purpureus	B	64.0 ± 1.8^{b}	79.0 ± .90^{c}	89.7 ± 1.4^{d}	73.2 ± 1.6^{c}
	O	68.6 ± .18^{b}	70.2 ± 1.1^{b}	88.5 ± 1.4^{c}	65.2 ± 3.2^{d}
	P	58.2 ± 1.3^{b}	73.6 ± 2.8^{c}	90.4 ± 3.8^{d}	60.8 ± .52^{e}
	A	58.7 ± .90^{b}	82.7 ± 1.2^{c}	90.5 ± 1.3^{c}	65.4 ± 1.0^{e}
L. siceraria	B	64.9 ± 3.6^{b}	83.0 ± 4.7^{c}	109.6 ± 2.4^{d}	69.6 ± 3.1^{b}
	O	65.8 ± 1.8^{b}	100 ± 2.2^{a}	110.9 ± 3.3^{c}	70.2 ± 3.9^{b}
	P	59.0 ± .37^{b}	73.8 ± 2.0^{c}	108.3 ± 5.0^{d}	59.4 ± 3.2^{b}
	A	67.1 ± 4.4^{b}	84.1 ± 1.6^{c}	129.0 ± 4.6^{d}	59.1 ± 1.6^{e}
L. acutangula	B	57.1 ± 7.5^{b}	63.2 ± 2.2^{c}	96.2 ± 3.2^{a}	86.1 ± 2.0^{d}
	O	55.6 ± 5.6^{b}	71.7 ± 5.1^{c}	105.5 ± 3.9^{a}	92.8 ± 2.2^{d}
	P	52.8 ± 2.7^{b}	73.9 ± 3.4^{c}	103.6 ± .74^{d}	100.1 ± .73^{ad}
	A	54.7 ± 1.5^{b}	100.9 ± 7.5^{a}	117.1 ± 12^{c}	94.7 ± 3.4^{a}
L. aegyptiaca	B	66.7 ± .26^{b}	94.4 ± 7.3^{c}	97.6 ± 3.4^{a}	71.3 ± 1.3^{c}
	O	63.0 ± 2.4^{b}	81.6 ± 6.2^{c}	94.4 ± .24^{a}	108.1 ± 4.8^{a}
	P	61.2 ± 1.8^{b}	68.5 ± .77^{c}	104.9 ± 5.0^{a}	78.2 ± 2.8^{d}
	A	67.6 ± 3.4^{b}	76.9 ± 4.4^{c}	107.9 ± 2.2^{a}	78.9 ± 10.1^{c}
M. charantia	B	62.1 ± 8.3^{b}	64.7 ± 3.4^{b}	79.6 ± 2.3^{c}	64.3 ± 1.2^{b}
	O	48.5 ± .35^{b}	59.6 ± 1.1^{c}	86.8 ± 3.1^{d}	58 .0 ± 1.4^{e}
	P	47.7 ± .88^{b}	56.6 ± 3.2^{c}	88.9 ± 4.5^{d}	56.0 ± 2.8^{c}
	A	57.5 ± 2.1^{b}	60.4 ± 1.7^{b}	92.3 ± .48^{c}	65.7 ± 4.9^{c}
S. melongena	B	59.4 ± 2.3^{b}	70.1 ± 5.2^{c}	86.8 ± 4.5^{d}	80.4 ± 3.8^{d}
	O	71.9 ± 8.4^{b}	75.0 ± 3.4^{b}	98.1 ± 3.6^{a}	84.8 ± .35^{c}
	P	52.7 ± 1.3^{b}	73.1 ± 4.0^{c}	79.9 ± 5.1^{d}	74.3 ± 3.6^{c}
	A	64.9 ± 2.0^{b}	103.9 ± 9.1^{ac}	109.9 ± 6.0^{c}	79.6 ± 4.4^{d}
T. cucumerina	B	40.5 ± .20^{b}	58.7 ± 1.6^{c}	107.1 ± .51^{d}	44.9 ± 3.7^{e}
	O	60.3 ± .20^{b}	61.9 ± 1.3^{b}	98.7 ± 1.0^{a}	36.4 ± 3.5^{c}
	P	50.2 ± 2.8^{b}	52.7 ± .90^{c}	98.3 ± 3.0^{a}	40.5 ± 1.0^{d}
	A	52.1 ± .13^{b}	60.1 ± 1.5^{c}	98.0 ± .04^{d}	38.2 ± 1.6^{c}
T. dioica	B	65.0 ± 4.7^{b}	78.7 ± .81^{c}	100.9 ± 4.4^{a}	78.7 ± 2.5^{c}
	O	59.2 ± 2.0^{b}	62.6 ± .54^{b}	98.6 ± 1.9^{a}	88.0 ± 3.4^{a}
	P	41.0 ± .26^{b}	61.2 ± .53^{c}	102.9 ± 1.2^{d}	94.6 ± 1.7^{d}
	A	58.7 ± .80^{b}	67.6 ± 1.5^{c}	106.2 ± 1.3^{d}	104.5 ± 1.2^{e}
V. unguiculata	B	42.4 ± 1.3^{b}	58.9 ± 3.6^{c}	77.9 ± 1.7^{d}	58.1 ± 5.8^{c}
	O	48.1 ± 8.5^{b}	67.8 ± 11^{c}	85.2 ± 7.3^{d}	64.8 ± .20^{c}
	P	46.2 ± 2.5^{b}	57.4 ± 2.2^{c}	88.1 ± .82^{d}	47.8 ± .20^{b}
	A	46.8 ± 4.4^{b}	68.5 ± 2.0^{c}	96.9 ± 1.7^{a}	53.4 ± 2.1^{d}

AA = Ascorbic acid, B = Boil, O = Microwave oven, P = Pressure cooker and A = Autoclave. Same alphabet indicates non significant analyzed by Anova ($p < 0.05$) where Control = 100^{a}.

CHAPTER SIX

DISCUSSION

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DISCUSSION

The antioxidant activity of the individual compounds may depend on structural factors, such as the number of phenolic hydroxyl or methoxyl groups, flavone hydroxyl, keto groups, free carboxylic groups and other structural features (Patt and Hudson, 1990). Antioxidants are believed to intercept the free radical chain of oxidation and to donate hydrogen from their phenolic hydroxyl groups, thereby forming a stable end-product, which does not initiate or propagate further oxidation of lipids (Sherwin, 1978). Lipids hydrogen peroxides are reported to cause apoptosis in PC12 cells (Aoshima et al., 1997). Polyphenols are the most abundant antioxidants in the diet. Among the plant-originated dietary intake of antioxidants they are at the top (Hossain et al., 2002). They also have anti-hyperglycemic effects (Hossain et al., 2002; Hanamura et al., 2006) and inhibit the development of diabetes (Zunimo et al., 2007).

However, various fruits and vegetables have antioxidant activity and components reportedly polyphenols and flavonoids are antioxidants that have various beneficial activities to physiological health (Hossain et al., 2008). Most fruity vegetables undergo cooking before consumption. When vegetables are submitted to cooking processes, such as boiling, microwaving, autoclaving, and pressure-cooking variations appear in their polyphenol compounds or antioxidant activity. These variations depend on the vegetable themselves (bioactive compounds), the cooking method, the bioavailability of phenolics (Sultana et al., 2007), temperature, the localization of the bioactive compounds in the vegetables, cutting, chopping (Makris and Rossiter, 2001), stability of the compounds to heat (Prasad et al.,1996; Pedraza-Chaverri et al., 2006), the synergic activity of the phytochemicals and on the reaction systems assayed, for example, β-carotene is an efficient singlet oxygen quencher but is not a hydrogen (Yamaguchi et al., 2001). Four possibilities are suggested for the increase in antioxidant activity of some vegetables after cooking: (1) the liberation of high amounts of antioxidant components due to the thermal destruction of cell walls and sub cellular compartments; (2) the production of stronger radical-scavenging antioxidants by thermal chemical reaction; (3) suppression of the oxidation capacity of antioxidants by thermal inactivation of oxidative enzymes; (4) production of new non nutrient antioxidants or the formation of novel compounds (Morales and Babel, 2002).

The results presented here clearly demonstrate that cooking can make the antioxidant capacity of cooked food quite different from that of uncooked food. This is most probably caused by a variety of effects, including destruction, release, and transformation of food components. In this study, autoclaving produced highest amount of total phenolic content and antioxidant activity of the fruity vegetables, followed by pressure cooking, microwaving and boiling. Cooking in water seems to cause a leakage of vegetable antioxidants into the cooking water and this effect increases with cooking time.

All the fruity vegetables produced higher total phenolics and antioxidant activity in autoclaving. Each vegetables possessed higher amount of phenolics at every time duration than uncooked. The amount of phenolics decreased as time progress. Phenolic contents were higher because of phenolics are usually stored in vegetables in pectin or cellulose networks and can be released during thermal processing, individual phenolics may sometimes increase because heat can break supramolecular structures, releasing the phenolic sugar glicosidic bounds, which react better with the Folin–Ciocalteau reagent (Bunea et al., 2008). Vegetables showed highest phenolics at 2 minutes and lowest at 20 minutes. Among vegetables *L. acutangula* and *F. hispida* showed higher results whereas *T. dioica* and *L. purpureus* showed lower results.

On the other hand, DPPH free radical scavenging and reducing power activity decreases with increasing time duration. Both of them showed highest results at 2 minutes and lowest at 20 minutes. In general, cooked vegetables showed higher scavenging activity at 2 and 5 minutes whereas lower at 10 and 20 minutes than uncooked. Among vegetables *T. dioica* and *C. mixta* showed higher scavenging activity whereas *C. dipsaceus* and *T. cucumerina* showed lower results. In reducing power, vegetables produced higher activity at 2, 5 and 10 minutes cooking than uncooked. Among vegetables *L. siceraria* and *A. esculentus* showed higher activity whereas *C. mixta* and *M. charantia* showed lower results.

In case of total antioxidant capacity, vegetables showed increasing activity as time progress, reached at the valley at 10 minutes and then gradually decreased. This activity was higher at 20 minutes and lower at 2, 5 and 10 minutes cooking than uncooked. Vegetables produced highest total antioxidant activity at 10 minutes whereas lowest at 2 minutes cooking. Within vegetables *S. melongena* and *A. esculentus* showed higher total antioxidant capacity whereas *M. charantia* and *T. cucumerina* showed lower results.

Pressure cooking and microwaving heating retains the active components in the cooked tissue (Yamaguchi et al., 2001) showed an intermediate condition in case of total phenolics and antioxidant activity of fruity vegetables. The activity of vegetables cooked in the microwave oven was generally higher than that of those cooked in boiling water, because microwave heating, griddling and baking does not stimulate the release of ascorbic acid or other antioxidants from cooked tissue (Prasad et al., 1996; Pedraza-Chaverr´ı et al., 2006). On the other hand, boiling may decrease the activity by decreasing ascorbic acid while higher activity may occur as consequence of the inactivation of oxidative enzymes such as ascorbate oxidase (Yamaguchi et al., 2001).

From the results of this study, autoclaving and pressure cooking as a cooking method and 2 minutes as cooking time are suitable to get higher amount of total phenolics and antioxidant activity whereas 10 minutes will be another better way to get higher total antioxidant capacity. There was a general decrease of the phenolics and antioxidant as the cooking time increased. The results agreed with similar findings that, the antioxidant decreases when vegetables juices are cooked for 10 minutes (Gimba et al., 2012). In addition, using the cooking water for soups and gravies should be considered for increasing antioxidant intake from vegetables. The effect of cooking on nutrient availability or loss, especially the antioxidant capacity, should be investigated in other vegetables and foods in order to better guide food preparation methods that do not deplete food of their rich antioxidant capacity. However, further *in vitro* and *in vivo* studies are needed to confirm the present observations. Attention should be paid to potential cytotoxic effects when they are used for the preparation of dietary supplements and in the enrichment of beverages or foods. Moreover, fractionation of potential extracts is essential for determining the phenolic or nonphenolic compound(s) responsible for the anti oxidative activities (Hossain et al., 2008).

CHAPTER SEVEN

CONCLUSION

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CONCLUSION

Bangladesh is a very poor country. About 80% of people are farmer and 47% people live from hand to mouth. But our country is resourceful and different kinds of vegetables are grown here. It is impossible for them to take expensive anti-oxidative drugs or to eat the costly fruits like apple, grape fruits, orange, litchi, mango, pineapple and so on. In the present study, anti-oxidative activities of common fruity vegetables were taken which are cheap and cosmopolitan in all parts of Bangladesh. It also serves a database providing information on the effects of different cooking methods with different time duration on total phenolics and antioxidant potential of these vegetables. This investigation showed that autoclaving and pressure cooking as a cooking method and 2 minutes as cooking time are suitable to get higher amount of total phenolics and antioxidant activity whereas 10 minutes will be another better way to get higher total antioxidant capacity. So, these fruity vegetable can be consumed by all classes of people as biological antioxidants.

The results of the study might encourage the food industry to recommend particular cooking methods to get the antioxidant properties of vegetables. The investigation showed the presence of anti-oxidative compounds in the vegetables after cooking with different time duration, but there were limitations to get a concrete indication of any specific antioxidants in vegetables. However, further research is needed to increase knowledge regarding the bioavailability of antioxidant compounds from vegetables after cooking and to confirm effects of different domestic cooking methods on the concentration and structure of these compounds in order to assign certain cooking methods and time of vegetables for using as the highest source of antioxidant to the poor people of the Bangladesh as well as the world.

CHAPTER EIGHT

REFERENCES

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CHAPTER NINE

APPENDIX

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1. Arithmetic Mean ($\overline{X}$) = $\frac{\Sigma X}{n}$

Where, ΣX = Summation of Observed Value

n = No. of Observation

2. Standard Deviation (SD) = $\sqrt{\frac{\Sigma(X-\overline{X})^2}{n}}$

Where, X = Individual Value

$\overline{X}$ = Mean Value

n = No. of Observation

3. Standard Error (SE) = $\frac{SD}{\sqrt{(n-1)}}$

Where, SD = Standard Deviation

n = No. of Observation