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Utilization of vegetables as a source of dietary fiber in conventional product

Abstract

Dietary fiber is that part of plant material in our diet which is highly resistant to enzymatic digestion .It includes cellulose, hemicellulose, gums and mucilages. The diets which contains high content of dietary fiber include nuts, cereals fruits and vegetables. High dietary fiber intake protects from many chronic diseases like gastrointestinal tract problems, cancer, heart diseases and obesity. Fruits and vegetables contain great amount of dietary fiber in them and can be used in development of various products such as bakery, beverages and supplements. In the current project three vegetables taken considered as high dietary fiber to extract dietary fiber from them. *Solanum lycopersicum*, L. (Tomato), *Brassica oleracea*, L. (cabbage) and *Ipomea batatas*, (L.) *Lam*. (sweet potato) were analyzed. The chemical analysis of these vegetables fat%, ash%, moisture%, fiber%, protein% in addition to carbohydrate%. A product (muffin) was prepared of all these samples separately for entire dietary fiber analysis. The total dietary fiber of *Brassica oleracea*, L. (cabbage) was 7.21g, for *Solanum lycopersicum*, L. (tomato) was 6.43g and for *Ipomea batatas*, (L.) *Lam*. (sweet potato) the fiber content was 14.9g which shows that sweet potato has highest content of dietary fiber. It provides essential nutrients and helps to overcome the deficiency of dietary fiber in body as a baked product. It is formed as little cost supplement and available local source of vegetables.

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Introduction

Human nutrition depicts the ways which are very effective and useful to reduce the chances of many diseases and the factors which are identified as major risk. The functional foods made by driving important components from plants and animal based foods plays major role in providing nutrients which are essential for growth and nutrition. The nutrients from botanical sources are more easily comestible and available to digestion system creating defense mechanism against diseases originated from malnutrition. The sickness condition of the various organs and frameworks will decide the supplement necessities of the body.[1] Regular dietary fiber requirement can be met by consuming a lot of fruits and vegetables, potatoes, grains, nuts and seeds. The EFSA's NDA Panel assessed that the normal dietary fiber intake in Europe fluctuate from 10-20 g each day in small kids from 15-30 g each day in young people, and from 16-29 g each day in adults.[2]

The term "dietary fiber" in food was first described by in 1953.[3] and it is categorized into two binary groups i.e. water- insoluble/less agitated fibers: lignin, cellulose, hemi cellulose and water soluble/well agitated fibers: pectin, gums and mucilage.[4] After passing year dietary fiber term was considered to contain fragments of consumable plants like polysaccharides and other related constituents remain unaffected by digestive system enzymes during digestion. Dietary fiber is also found in seed grains of many cereals, pulses and legumes in form of indigestible carbohydrates portion. It is also named as roughages or bulk but this term may be ambiguous because of non-bulky texture of some of the fibers. Dietary fiber has positive strong role in human health to prevent constipation, irritable bowel syndrome (IRB), colon infection and diverticulitis like diseases.[5] It seems to have impacts for our digestive health and regular bowel movement. Certain eating regimens or explicit food parts could subsequently assist with forestalling illnesses that are connected with poor quality irritation.[6] Dietary fiber and prebiotic compounds, found in fruits and vegetables, extensively work on humans through these components, for example, metabolic regulation, normalizing the cholesterol level, decrease of postprandial glycemic index, interaction of the phenolic compounds, forestalling blockage etc.[7] Vegetables contribute nutrients, fiber, vitamins and minerals to the human beings. They are good source of oil, carbohydrates, carotene, ascorbic acid, retinol, riboflavin, folic acid playing crucial role depending upon the consumption dose.[8] It is worth to observe that minerals and vitamins are not synthesized in bodies of humans and animals and these must be provided by foods derived from plant sources. These are especially very important in developing countries where poverty and climatic conditions effect the lives of people to great extent. There is a rising awareness among the population of the these countries to take diets wealthy in vegetables to guarantee a sufficient intake of most micronutrients, vitamins, phytochemicals and dietary fibers that provide complete nutrition.[9]

Cabbage is an important crop which contains abundant amount of dietary fiber. Cauliflower has a very high waste index[10] and is excellent source of dietary fiber due to which it also possesses antioxidant and ant carcinogenic properties.[11] Dietary fiber composition of cauliflower remain assessed to stay around 5% of the complete mass or around half of the all-out dehydrated weight, comprising of around 40% no starch polysaccharides.[12] Significant phytochemicals in Tomato are carotenoids comprising of 10-12% phytoene, 10- 15% carotenes, 60-64% lycopene and 7-9% neurosporene. The normal everyday intake of lycopene in our daily intake is around 25 mg/day; almost 85% is obtained from tomato items.[13,14] The consumers are presently turning out to be more conscious about their health and interested in the nutritional benefits of food items that lead to the extraordinary requirement for the advancement of food varieties that can satisfy the requirements of dietary fiber and polyphenols in the daily routine.[15] Considering all facts mentioned above basic purpose of this research work is the development of dietary fiber enriched muffin prepared from natural botanical sources for the healthy lifestyle of people. The development of low cost baked product from easily available local sources of vegetables provide essential nutrients to overcome the deficiency of nutrients.

Methodology

Chemical analysis

The proximate analysis that is moisture, ash, fat, protein, fiber for selected vegetables i.e. Tomato, sweet potato and Cabbage was determined by AOAC.[20]

Estimation of carbohydrates

Carbohydrates were determined by difference method.

Carbohydrates % = 100 – (moisture + ash + fat + fiber + protein).

Mineral characterization:

Mineral contents are estimated by the method of AOAC (2012).

Preparation of muffins

Muffins were prepared according to the method explained by Vasantha Rupasinghe HP.[16] The oven was preheated to 191°C. Muffin pans were buttered. The flour, baking powder, salt, vegetable powder (cabbage, tomato and sweet potato separately) and sugar were mixed. Egg, milk, and butter were added. Ingredients were stirred enough to dampen the flour; the batter was not kept smooth. About two-third portion of each muffin pan was filled with batter. Baking was done for about 20 to 25 minutes each. Cooling of muffins was done at room temperature (25°C) under controlled conditions. Physical study was accomplished within 3 hours to retain the uniformity of preparation. Percentages of ingredients done on weight by weight (w/w) premise and vegetable rates were changed by supplanting equivalent extents of wheat flour.

Total dietary fiber analysis

The meaning of all out dietary fiber has prompted fitting enzymatic strategies secluding the parts impervious to amylases and proteases. The system is taken on and teamed up by AOAC. Tomato, sweet potato and cabbage muffin was heated. 1.00g of every trial of muffin was gauged as well as occupied into the dialysis tube. 30ml of 8M urea arrangement that comprises 50µl of intensity constant amylase was added into the test tube. The arrangement was apprehended at room temperature for around 3.5 to 4.5 hours. 5µl of protease was estimated from pipette and added into the dialysis tube. The test tubes were set into water shower of 50ºC that had a constant water trade. The test tubes were dialyzed for 2 to 6 hours. Every one of the items in the cylinder were moved to container and 4 volume of ethanol was added into it. The arrangement was separated into the cone shaped jars and let it to dry at 100ºC. The precipitates were whole dietary fiber content of the chosen muffin.

$$TDF\% = \frac{\text{Residue wt} \times 100}{\text{Original wt}}$$

Sensory evaluation of muffins

Sensory evaluation was performed to study organoleptic characters of color, texture, flavor, taste, aroma and volume index by following methods explained.

Results and discussion

Vegetables are a very important element of the human diet because of the fact that they contains many important substances. . These are great source of fiber, which brings down the body cholesterol level, reduces the chances of cardiac illnesses. Vegetables should to be utilized habitually as they proved great for heath and gives the nutrients to body when consumed in suitable combination.[17] vegetables are viewed as fundamental for even weight control plans since they supply nutrients, dietary fiber, minerals, and phytochemicals tomato by products consists of peels and seeds and peel contains high amount of fiber. Tomatoes are one of the vegetable that is a valuable source of dietary fiber, antioxidants and tocopherol. Ash quantity was great since the peel byproduct contained 83.8 g kg^{-1} sodium as outcome of using a sodium hydroxide solution to peel the tomatoes. Almost 0.7% of the lycopene in the seed byproduct and around 0.1% of the lycopene in peel byproduct were transferred from the forage to the yolk. Lycopene seems more comparable to carotene than to oxy-carotenoids in its transference to the yolk.[18] Moreover it could be observed that the proximate analysis of selected tomato of this research topic has moisture, ash, fat, protein and fiber content as 93.9, 0.37, 8.26, 5.31 and 11.8 respectively. The moisture content in Tomato is highest.

Intensities of some nutrients and anti-nutrients of sweet potato, leaves were determined by means of average investigative method. Crude protein, crude fiber, crude fat, ash, carbohydrate, moisture content and caloric values were 24.85%, 4.90%, 7.20, 11.10%, 51.95%, 82.21%and 351.30 kcal respectively.[19] However, it could be experimentally perceived that the proximate analysis of sweet potato of this research work has moisture 81.3, ash 45.6, fat 6.4, protein 5.625 and fiber 31.5 respectively. The content of fiber in sweet potato is very high with the related analysis. Sweet Pepper, Cabbage, Tomato, Carrot, Cauliflower, Lettuce, Potato, Reddish, Spinach, also Bottle Gourd remain studied for their nutrients, mineral and vitamin contents to assess their prominence in human diet. The results presented that nearly all vegetables comprises considerable quantity of important nutrients. Moisture content was great ranging from 77% in potato to 94.5% in bottle gourd monitored by carbohydrate in all particular vegetables. Crude protein, ash and Crude fiber were in range from 0.9 to 2.1%, 0.5% to 1.1% and 0.3 to 1.2% respectively. Sweet pepper was originated to be uppermost in crude fiber content. Whereas the proximate analysis of cabbage in this research work has moisture 93.1, ash 4.7, fat 11.3, protein 5.46 and fiber 9.6.

The comparison of proximate analysis of vegetables is given in Table 1 and there was great deviation happen among the %ages of ash, moisture, protein, fat as well as crude fiber contents. Sweet potato contained high ash contents percentage are 45.6 respectively. High percentage of moisture contents was observed in tomato and cabbage are 93.9 and 93.1 respectively. High percentage of fat and contents was observed in cabbage are 11.3 respectively. High percentage of protein and crude fiber contents was observed in sweet potato are 5.625 and 31.5 respectively. AOAC method is used to conduct proximate analysis of vegetables Tomato (*Solanum lycopersicum*, L.), *Sweet potato* (*Ipomea batatas*, (L.) Lam and Cabbage (*Brassica oleracea*, L.). The proximate analysis of the products (muffins) prepared out of it. The dietary fiber analysis is also conducted under the protocol of AOAC 2012.[20,21] Proximate study of tests was completed by deciding the dampness, debris, fat, fiber, protein and sugar content. The examples were investigated by the methodology of AOAC, 2012. All the purposes were carried out in triplicate. The following results were obtained.

The sweet and high caloric baked product, muffins, is popular among regulars of all time of life sets because of their soft surface as well as sweet taste.[22] Likewise in the present research high dietary fiber muffins were made for regular intake. The proximate analysis of muffins prepared out of the samples of cabbage has moisture 35.72, ash 8.38, fat 13.6, protein 7.16 and fiber 16.4 respectively. The moisture content in cabbage muffin is high. The proximate analysis of muffins prepared out of the samples of tomato has moisture 30.81, ash

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5.41, fat 28.1, protein 7.2 and fiber 17.3 respectively. The moisture content in tomato muffin is highest. The proximate analysis of muffins prepared out of the samples of sweet potato has moisture 28.5, ash 9.72, fat 14.1, protein 7.81 and fiber 39.3 respectively. The fiber content is very high in sweet potato muffin.

Table 1 Comparison of proximate analysis of vegetables

S. No.	Contents	*Solanum lycopersicum*, L. (Tomato)	*Ipomea batatas*, (L.) Lam (Sweet potato)	*Brassica oleracea*, L. (Cabbage)
1	Ash	0.37±0.1	45.6±0.1	4.7±0.1
2	Fat	8.26±0.01	6.4±0.1	11.3±0.1
3	Moisture	93.9±0.057	81.3±0.05	93.1±0.05
4	Protein	5.31±0.01	5.625±0.009	5.46±0.01
5	Crude fiber	11.8±0.1	31.5±0.1	9.6±0.1

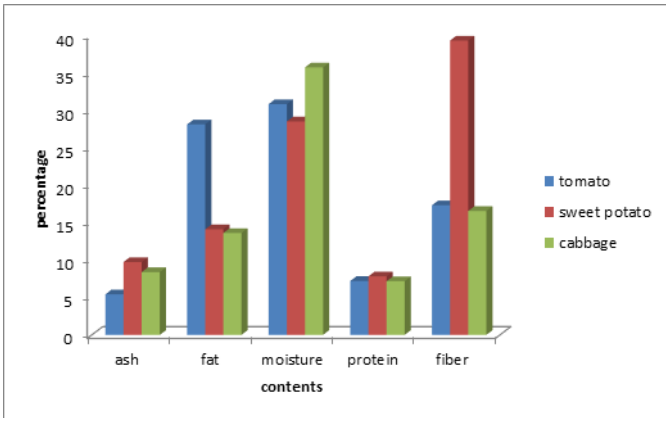

Figure 1 Graphical representation of comparison of proximate analysis of vegetables.

The comparison of proximate analysis of vegetable muffin is given in Table 2 and there was great deviation happen among the %ages of ash, fat, moisture, crude fiber and protein contents. Cabbage muffin contained high moisture contents proportion is 35.72 respectively. Great percentage of fat contents was observed in tomato muffin was 28.1 respectively. High percentage of ash, protein and crude fiber contents was observed in sweet potato muffin was 9.72, 7.81 and 39.3 respectively

Table 2 Comparison of proximate analysis of vegetable muffin

S. No.	Contents	*Solanum lycopersicum*, L. (Tomato) muffin	*Ipomea batatas*, (L.) *Lam* (Sweet potato) muffin	*Brassica oleracea*, L. (Cabbage) muffin
1	Ash	5.41±0.01	9.72±0.01	8.38±0.01
2	Fat	28.1±0.1	14.1±0.1	13.6±0.1
3	Moisture	30.81±0.01	28.5±0.1	35.72±0.01
4	Protein	7.2±0.1	7.81±0.01	7.16±0.01
5	Crude fiber	17.3±0.1	39.3±0.1	16.54±0.01

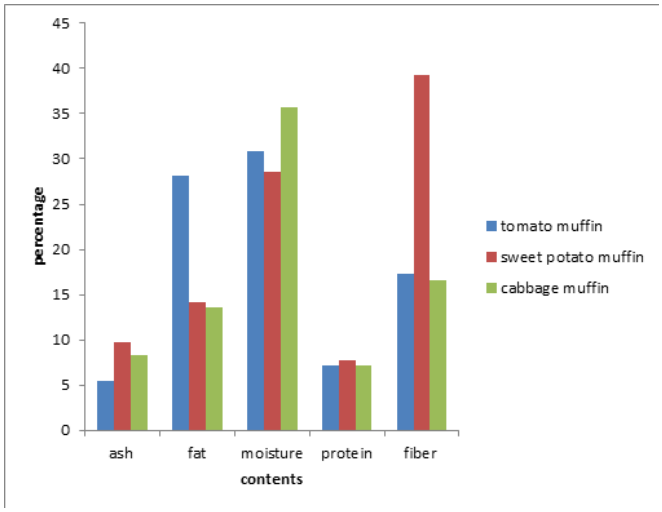

Figure 2 Graphical representation of comparison of proximate analysis of vegetable muffin.

Minerals and vitamins are normally happening substances found in food, and are fundamental for biochemical cycles in the human body. Such supplements are indispensable for the guideline of body liquid content and typical body work. Adequate admission of nutrients also minerals can forestall the advancement of micronutrient inadequacy associated infections.[23]

Fe is fundamental in the avoidance and treatment of weakness. The Fe content in yam assortments dissected went from 0.91 - 1.40 mg/100 g dry weight (DW) announced. In contrast with a few different examinations.[24,25] we found generally speaking higher Fe levels though our perceptions that is Fe content ran 1.34 mg is near the discoveries.[26,27] inferred that the Fe content in cabbage ran 0.75 while our discoveries of Fe content in cabbage ran 0.92 mg. With regard to Iron concentration, the garden-fresh treated tomato was found to be highest that is 34.45 mg/kg reported by[28] and in this study the Fe content is also higher i.e. 35.36 mg respectively.

Ca content in the assortments went from 21.98 - 27.35 mg/100 g DW affirmed. Revealed that Ca content in sweet potato assortments fluctuated from 23.04 - 29.97 mg/100 g DW and announced 50 mg/100 g DW. While in our perceptions the Ca content ran 1.67 mg saw as like the revealed values portrayed that Ca content in cabbage went 19.88mg. Detailed the new tomato has minimal grouping of calcium. Compared to other mineral components, K was available in the most elevated sums in all of the yam tests tried. The K qualities archived from the examined tests (310.04 to 368.35 mg/100 g DW) is lower than that (338.00 to 407.04 mg/100 g) detailed.[29] yet higher than the qualities (191.00 to 334.00 mg/100 g) detailed reported that K values ranged 53.42 mg. Stated the fresh tomato has K value 61.90 mg. reported the amount of Mg in the particular sweet potato assortments diverse from 21.28 - 25.40 mg/100 g DW stated the Mg amount in cabbage ranged 22.60mg. described the Mg content in tomato varied 76.87mg.

Mineral characterization of vegetables showed in Table 3 and there is a great variation of Fe, Ca, K and Mg. Tomato contained high iron content is 35.36 respectively. Great percentage of calcium and potassium was observed in sweet potato i.e. 22.78 and 345.26. The lowest calcium content observed in tomato was 1.67. Great percentage of Magnesium content was found in tomato i.e. 76.99 respectively.

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Table 3 Mineral Characterization of vegetables

S. No.	Contents	*Solanum lycopersicum*, L. (Tomato)	*Ipomea batatas*, (L.) Lam (Sweet potato)	*Brassica oleracea*, L. (Cabbage)
1	Iron (Fe)	35.36±3.2	1.34±0.07	0.92±0.04
2	Calcium (Ca)	1.67±0.09	22.78±1.3	18.98±0.43
3	Potassium (K)	64.86±3.1	345.26±2.1	56.1±0.54
4	Magnesium (Mg)	76.99±2.3	24.59±1.07	23.11±2.10

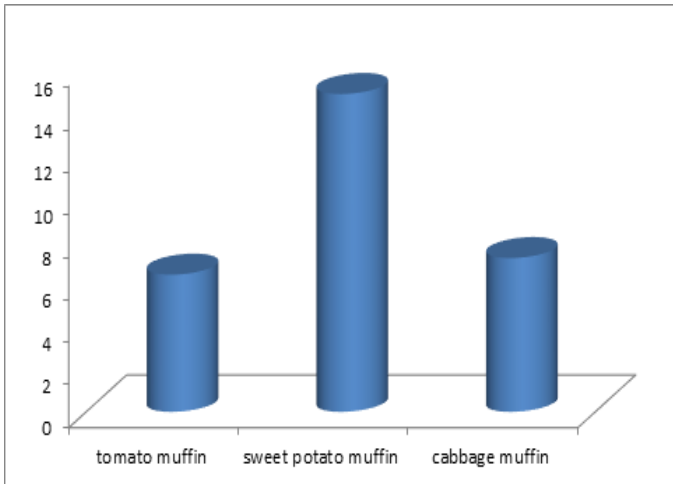

Figure 3 Graphical representation of estimation of TDF of samples.

Researchers focused in on the utilization of leafy foods for consumption of dietary fiber. They showed the assumed defensive impact of organic product, vegetable and dietary fiber utilization on colorectal disease risk. This was normal in focal Sweden ladies. They were determined to have colorectal disease this was because of low admission of products of the vegetables which are exceptionally fibrous.[30] The meaning of diet strands has driven the improvement of a huge as well as expected advertise for fiber-rich items and fixings and lately, there is a design to observe firsthand wellsprings of dietary fiber that can be consumed in the sustenance business.[31]

Table 4 shows the dietary fiber content in tomato, sweet potato and cabbage muffin is 6.43, 14.9 and 7.21 respectively. The dietary fiber content is high in sweet potato. The means found for the sensory evaluation and tolerability of vegetable muffins enriched with dietary fiber. The samples did not differ statistically from each other in any aspect attaining higher scores in all. The trials are acknowledged by the juries. The color, texture and size of muffins depict great appearance to attract consumers. The taste of sweet potato and cabbage muffin resulted excellent while the tomato muffin seems fair when add it in low percentage. The aroma for the muffins appears good appealing to eat by all. However, the result shows good acceptability of muffins made from vegetables which can be offered for consuming as substitute product. There is a great ultimatum of muffins among consumers now days. It should be a great choice to add such vegetable baked products enriched with dietary fiber in diets as it is also high in nutrition.[32–36]

Table 4 Estimation of TDF of samples

Contents	*Solanum lycopersicum*, L. (Tomato) muffin	*Ipomea batatas*, (L.) *Lam* (Sweet potato) muffin	*Brassica oleracea*, L. (Cabbage) muffin
%age	6.43	14.9	7.21

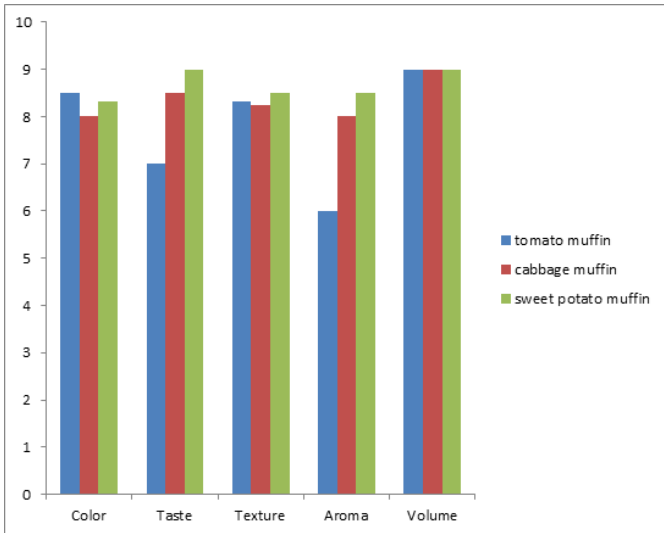

Figure 4 Sensory Evaluation of tomato, cabbage and sweet potato muffins.

Conclusion

From the outcome of present study it can be concluded that vegetables has great dietary fiber content. The dietary fiber composition of *Solanum lycopersicum*, L. (tomato), *Brassica oleracea*, L. (cabbage) and especially the *Ipomea batatas*, (L.) Lam (sweet potato) as it contains high dietary fiber. Sweet potato and the muffin prepared out of it have great health benefits and could possibly protect consumers against many diseases such as cardiovascular diseases, diseases by lowering the cholesterol level, lowering the glycemic index, defensive against malignant growth, particularly gastrointestinal tumors like colonic disease and gastric, and chemical ward malignant growths including prostate and breast.

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None

Conflicts of interest

The authors declare no conflicts of interest.

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