ACTIVITY STUDIES OF SELECTED TUBER AND VEGETABLE POWDER MIX

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Abstract- Dioscorea alata (yam), Phyllanthus emblica (fruit) Colocasia esculenta(taro) and Momordica charantia (vegetable) has been used for this study. All are powdered and PE: DA and MC: CE are mixed in various ratios like 1:0, 1:2, 1:5, 1:8 and 0:1. Nutritional analysis were done for all the samples and moisture content, ash content, iron, phosphorous, starch and crude protein, crude fiber, carbohydrate, tannin, crude fat, vitamin c, iron, calcium were determined and are analyzed for DPPH, metal chelating and Phosphomolydenum antioxidant assays. Best of the mixed ratios of PE: DA and MC: CE has been selected for the development of product through extrusion process using two different temperatures 100ºC and 110ºC using a moisture of 12 % and 13% and the sample has been extruded and that extruded product has been analyzed for their functional properties. PE: DA (1:8) and MC: CE (1:8) ratio can be employed as a good nutritional and antioxidant extruded product among all the other ratios.

Index Terms- *Colocasia esculenta, Dioscorea alata, Momordica charantia, nutritional analysis, Phyllanthus emblica.*

I. INTRODUCTION

Tubers and roots are important major food sources in tropical and sub-tropical countries (Liu *et al.*, 2006). Taro corm is an excellent source of carbohydrate, and it contains starch ,17- 28% of amylase, low in fat and protein, however the protein content of taro corm is slightly higher than that of yam, cassava or sweet potato. The size of taro starch grain is one-tenth that of potato and its digestibility has been estimated to be 98.8%. Because of its ease of assimilation, it is suitable for persons with digestive problems (Onwueme *et al*., 1978).

Yam is the second important tropical root crop and it is a good source of energy and mainly composed of complex carbohydrates and soluble dietary fiber. Together, they raise blood sugar levels rather very slowly than simple sugars and therefore recommended as low glycemic index healthy food. In addition, dietary fiber helps in reducing constipation, it lowers bad (LDL) cholesterol levels by binding to the intestines and prevent colon cancer risks by preventing toxic compounds in the food from adhering to colon mucosa (Kritikar *et al*. 1956).

Fruits and vegetables are the most important natural products very much beneficial on the human health point of view. Bitter gourd fruits are a good source of carbohydrates, proteins, vitamins, and minerals and have the highest nutritive value among cucurbits. Considerable variation in nutrients, including protein, carbohydrates, iron, zinc, calcium, magnesium, phosphorous, and ascorbic acid has observed. (Soni *et al*., 1993). *P. emblica* (Amla) Linn fruit is commonly used for the treatment of anorexia, constipation, piles, leucorrhea, inflammatory bowls, cough, hemorrhoids, fever, thirst, toxicity of blood and atherosclerosis and It has significant antidiabetic and hypotriglyceridemic activities (Thakar *et al.*, 1984)

2. MATERIALS AND METHODS

2. 1 Sample preparation

Colocasia esculenta, Dioscorea alata, Momordica Charantia and Phyllanthus emblica was collected from local markets of Coimbatore. The tubers and the fruits were washed separately, and the non edible portions were discarded. The tuber and the fruits were then peeled, cut in to pieces and dried in hot air oven and powdered by passing through 60 mesh sieve and stored in air tight container till further use. Different ratios were prepared by mixing Colocasia esculenta, Momordica charantia powders and Dioscorea alata and Phyllanthus emblica in the ratios of (1:0), (1:2), (1:5), (1:8) and (0:1) and it was named PE: DA, MC: CE respectively. The samples were labelled as PE: DA (1:0) to PE: DA (0:1) and MC: CE (1:0) to MC: CE (0:1)

2. 2 Chemical analysis

Moisture, ash, crude fiber, Iron, calcium, crude fiber analysis of the samples is determined by following AOAC (2000) method. Proteins content analyzed by Micro Kjeldahl (AACC, 1990) method. Carbohydrate estimated by following the procedure of Raghuramulu *etal.*, 1983. Fat percentage estimated by soxhlet– extraction, (Pearson *et al*., 1985). Phosphorous determined by spectrophotometrically method following methods reported by Helrich,1990. The ascorbic acid content is quantitatively analyzed by the method by Ranganna *et al*.,1997. The starch and tannin content was determined by the methods reported by M Crae. J. C, 1971 and Joslyn, 1970 respectively.

2. 3 In vitro Antioxidant Assays

2. 3. 1 Sample preparation for antioxidant assay
All the samples were packed in soxhlet separately and extracted with methanol. The solvent extracted is concentrated by rotary vacuum evaporator and then dried in vacuum oven.

2. 3. 2. Phosphomolybdenum assay
The antioxidant activity of samples was evaluated by the green phosphomolybdenum complex formation according to the method of Prieto *et al.*, 1990.An aliquot of 100 µL sample and ascorbic acid in 1 mm dimethyl sulphoxide (standard) or distilled water (blank) is added with 1 mL of reagent solution (0.6 M sulphuric acid, 28 mm sodium phosphate and 4 mm ammonium molybdate) in a test tube. The sample is incubated at 95˚C for 90 min. The samples are cooled and absorbance of the mixture was measured at 695 nm. The Total antioxidant capacity is expressed as mean values in mg of ascorbic acid equivalents/ gram extract.

2. 3. 3. DPPH radical scavenging activity
The antioxidant activity of the extract was determined in terms of hydrogen donating or radical scavenging ability using the stable radical DPPH, according to the method of Blios (1958). The sample extracts at various concentrations is taken and the volume is adjusted to 100 µL with methanol. About 5 mL of 0.1 mm methanolic solution of DPPH was added to the aliquots of samples and standards (BHA, BHT, Rutin and Vitamin E) and shaken vigorously. Negative control was prepared by adding 100 µL of methanol in 5 mL of 0.1 mm methanolic solution DPPH. The tubes were allowed to stand for 20 minutes at 27°C. The absorbance of the sample was measured at 517 nm against the blank. Radical scavenging activity of the samples was expressed as IC50 which is the concentration of the sample required to inhibit 50% of DPPH concentration.

2. 3. 4. Metal chelating activity
The chelating of ferrous ions by various extracts of sample was estimated by the method of Dinis *et al.* (1994). 100 µL of the extract and BHT (standard) were added to 50µLsolution of 2 mm $FeCl_2$. The reaction was initiated by the addition of 200 µL of 5 mm ferrocene and the mixture was shaken vigorously and left kept for 10 min. Absorbance taken at 562 nm against blank. The metal chelating capacity of the extracts is evaluated using the equation:
Metal chelating capacity (%) = $[(A_0 - A_1) / A_0] \times 100$,
where, A_0 is the absorbance of the control,
A_1 is the absorbance of the sample extract/standard.

2. 3. 5. Product development
The procedure for product development is given in Fig. 1

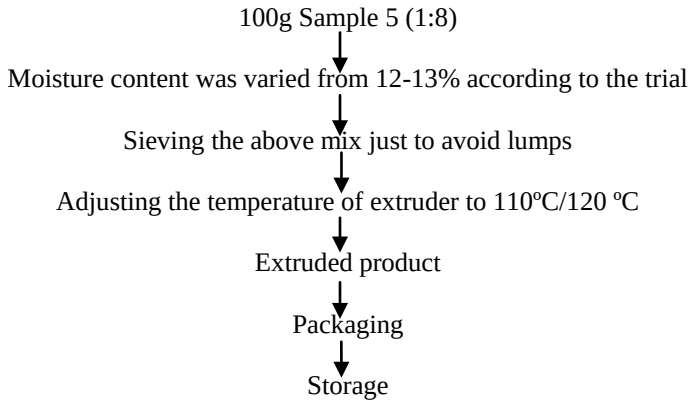

Figure 1: Flow chart for the development of product is as follows

2.3. 6. Extruded product analysis

Mass flow rate was determined by the method described by Singh *et al*., 1996.Bulk density was determined by the method described by Udensi *et al*. 2000. Swelling power and percent solubility was determined by the method described by Schoch 1964.

3. RESULTS AND DISCUSSION

3. 1 Chemical characteristics of various mixed ratios of PE: DA

The results indicate that moisture content of PE: DA (1:8) showed a highest moisture content of 6.18% when compared to the other mixed ratios. The observed high moisture levels of the tubers may influence the textural quality of *D. alata* food products or the stability. The higher the moisture content, the higher will be the rate of spoilage**.** The yam tuber, in general has high moisture content and a low level of dry matter which makes it difficult in preserving for a long period but it can be stored by converting it into various food products. (Opara, L. U. 1999).

PE: DA (1:8) was found to have an ash content of 4.38% which was higher when compared with other ratios. A comparable range of 13.68-37.4% dry matter content for *D. alata* varieties has been reported in the literature (Maziya-Dixon, B *et al*.,2003). Lebot *et al.,2005*, observed that *D. alata* varieties of good quality are characterized by high percentage of dry matter and starch contents. Ash content is a reflection of mineral status, and presently in both the tubers mixtures reflects high amount of mineral. Comparable ash content of 2.50-4.90% has been reported for *D. alata* tubers. The amount of ash in a tuber depends on the type of soil from which it was harvested, the moisture content and the maturity of the crop (Lebot *et al.,2005).*

Iron is required for blood formation and it is important for normal functioning of the central nervous system of carbohydrate, protein and fats. (Adeyeye *et al*., 2005). Analysis of iron content of PE: DA (1:8) powder is reported to have highest iron content of value 0.51mg/100g.

Calcium is vital for the development of healthy bones and normal functions of bones. It helps in muscle contraction and regulation of heartbeat, and it has major function during blood clotting. Shortage of calcium can lead to osteoporosis, that makes bones brittle and break easily (Umar *et al.*,2005). PE: DA (1:2) is found to have a highest calcium content of 20.18mg/100g.

Phosphorous content of PE: DA (1:8) was found to be 59.94mg/100mg which was higher when compared to the other samples. Phosphorus (P) is present in higher amounts in most foods because it is a critical component of all living organisms. About 800 mg of P is recommended for adults per day. Yam starches are reported to contain 3-4 times as much phosphorus as found in cassava and aroid ones (Johansen, H. N.*et al.*,1993). Moorthy and Nair, 1989 reported 0.11 and 0.015% phosphorus in *D. rotundata* grown in India. When compared calcium and phosphorous, phosphorus is the most abundant mineral required for body. About 85% of phosphorus in the body can be found in bones and teeth, but it is also present in cells and tissues throughout the body. Phosphorus helps to filter out waste in the kidneys and plays an essential role in storage of energy in the body. It helps in reducing muscular pain immediately after a hard workout (Johansen, H. N.*et al*.,1993).

Vitamin C is a highly effective antioxidant which helps to prevent damage caused to body cells by free radicals. The loss in vitamin C during drying involves oxidation and hydrolysis and it is more prone to degradation at high temperatures (Gregory *et al*.,2008). Amla is well known for its nutritional qualities. It is rich in polyphenols, minerals and is regarded as one of the richest source of vitamin C (200-900 mg per 100 g of edible portion). In this study PE: DA (1:2) has the highest amount of vitamin C of 38.9mg/100g as it is having Phyllanthus emblica alone.

Starch is known to account for about 80% on a dry weight basis of yam carbohydrate, starch content determines the physicochemical, rheological and textural characteristics of yam food products as reported by Moorthy, S.N. 1994. PE: DA (1:8) records the highest starch content of 5928mg/100g.

Tannin content was found to be high in PE: DA (1:2) which is having a value of 0.45mg/100g. Tannins have been reported to form complexes with proteins and reduce their digestibility and palatability (Eka, 1985). Tannins serve as a natural defense mechanism against microbial infections. The antimicrobial property of tannins can also be used in food processing to increase the shelf-life of certain foods. Tannins have also been reported to exert other physiological effects, such as to accelerate blood clotting, reduce blood pressure, decrease the serum lipid levels (Chun *et al*., 2002).

PE: DA (1:2) represents the higher crude fat value of 1.89%. Crude fat serve as energy store in the body. It can be broken down in the body to release glycerol and free fatty acids. The glycerol can be converted to glucose by the liver and used as a source of energy. (Gamman *et al.*,1996). PE: DA (1:2) represents the higher crude protein value of 17.16%.

PE: DA (1:2) was found to have a significant amount of crude fiber with a value of 1.78%. Crude fiber is positively related to different physiological and metabolic effects. It contributes less to calories, and can bind and flush cholesterol, carcinogens and undesirable chemicals from the body. It provides bulk, regulates intestinal motility and thereby helps to prevent the development of diverticulosis and chronic diseases including coronary heart disease, colonal cancer and other disorders of the gastrointestinal lining (Topping, D.L. et al, 2001).

Dioscorea alata have high carbohydrate content. More than 85% of the carbohydrate reserve in Dioscorea alata comprises of starch, generally utilized for its edible and medical values. From the results obtained while comparing all the mixed ratios, PE: DA (1:8) was found to have a highest carbohydrate content of value 74.41

3. 2 Chemical characteristics of various mixed ratios of MC: CE

The results indicate that moisture content of MC: CE (1:2) showed the highest moisture content 5.38% when compared with the other mixed ratios. The ash content of MC: CE (1:8) was found to be 5.37% which is higher than that of the other samples. Ash content is a reflection of mineral status, and presently in both the tubers mixtures reflects high amount of mineral. The amount of ash in a tuber depends on the type of soil from which it was harvested, the moisture content and the maturity of the crop (Lebot *et al.,2005).* The Iron content of MC: CE (1:8*)* was found to be 0.56mg/100g which was found to be the highest among all the mixed ratios. The Recommended Dietary Allowance for iron in adult and children is 10 mg/day, while female adult is 15 mg/day. Iron is required for blood formation and it is important for normal functioning of the central nervous system of carbohydrate, protein and fats. (Adeyeye *et al*., 2005).

The RDA for calcium is about 800-1200 mg for adults. Calcium is vital for the development of healthy bones and normal functions of bones. It helps in muscle contraction and regulation of heartbeat, and it has major function during blood clotting. Shortage of calcium can lead to osteoporosis, that makes bones brittle and break easily (Umar *et al.,*2005). MC: CE (1:2) is found to have a calcium content of 21.1 mg/100g and it was found to be the highest among the various mixed ratios.

The phosphorous content MC: CE (1:8) is found to have significant amount of 51. 3 mg/100g which is found to be highest among the various mixed ratios. In this study MC: CE (1:2) was found to be highest amount of vitamin C in the range of 10.3mg/100g among the various mixed ratios. Starch is known to account for about 80% on a dry weight basis of yam carbohydrate, starch content determines the physicochemical, rheological and textural characteristics of yam food products as reported by Moorthy, S.N. 1994. The starch content of MC: CE (1:8) was found to be 6278mg/100g. The result of the analysis indicates that starch content of the samples were high.

The results showed that MC: CE (1:2) was found to have a tannin content of 0.68mg/100g which was found to be highest among the mixed ratios. The crude fat content of MC*:* CE (1:2) was found to be 1.82% and was highest among the various mixed ratios. Crude fat serve as energy store in the body. It can be broken down in the body to release glycerol and free fatty acids. The glycerol can be converted to glucose by the liver and used as a source of energy. (Gamman *et al.*,1996).

The crude protein content of MC: CE (1:2) was found to be 12.69%. The result of the analysis indicates that crude protein content of the samples were very low. From the results it was observed that MC: CE (1:2) was found have crude fiber content of 2.13% and it was found to be higher when compared with other mixed ratios. Crude fiber is positively related to different physiological and metabolic effects. It contributes less to calories, and can bind and flush cholesterol, carcinogens and undesirable chemicals from the body. It provides bulk, regulates intestinal motility and thereby helps to prevent the development of diverticulosis and chronic diseases including coronary heart disease, colonal cancer and other disorders of the gastrointestinal lining (Topping, D. L, et al,2001). The results obtained showed that MC: CE (1:8) has a carbohydrate content of 87. 21mg/100g and was highest when compared with the various mixed ratios.

Table 1: Chemical characteristics of various mixed ratios of PE: DA

PARAMETERS	PE: DA (1:0)	PE: DA (1:2)	PE: DA (1:5)	PE: DA (1:8)	PE: DA (0:1)
Moisture content (%)	5.59±0.05[a]	5.96±0.03[a]	6.01±0.09[a]	6.18±0.07[a]	6.23±0.02[a]
Ash content (%)	2.96±0.09[a]	3.99±0.12[a]	4.12±0.08[a]	4.38±0.06[a]	4.65±0.11[a]
Iron (mg/100g)	0.32±0.15[a]	0.39±0.18[a]	0.48±0.11[a]	0.51±0.14[a]	0.56±0.12[a]
Calcium (mg/100g)	27.6±0.03[a]	20.18±0.05[a]	19.52±0.08[a]	18.89±0.02[a]	19.3±0.04[a]
Phosphorous (mg/100g)	0.12±0.14[a]	37.12±0.16[a]	43.29±0.13[a]	59.94±0.17[a]	57±0.15[a]
Vitamin C (mg/100g)	88.32±0.02[a]	38.9±0.05[a]	27.3±0.07[a]	21.98±0.04[a]	15±0.03[a]
Starch (mg/100g)	2565±0.15[a]	5042±0.23[a]	5673±0.20[a]	5928.6±0.28[a]	6429±0.24[a]
Tannin (mg/100g)	0.85±0.04[a]	0.45±0.12[a]	0.40±0.08[a]	0.35±0.07[a]	0.32±0.14[a]
Crude fat (%)	2.56±0.02[a]	1.89±0.01[a]	1.67±0.04[a]	1.54±0.03[a]	1.38±0.02[a]
Crude protein (%)	35.7±0.18[a]	17.16±0.12[a]	14.12±0.22[a]	11.9±0.29[a]	7.52±0.26[a]
Crude fiber (%)	1.98±0.20[a]	1.78±0.28[a]	1.62±0.25[a]	1.59±0.18[a]	1.52±0.23[a]
Carbohydrate (mg/100g)	51.21	69.22	72.46	74.41	78.7

3. 3 IN-VITRO ANTIOXIDANT ASSAY

3. 3. 1 DPPH radical scavenging activity of different ratios of PE: DA

The DPPH radical scavenging activities of different ratios of PE: DA are shown in Figure 2 and 3. DPPH is a stable free radical which is commonly used for assessing antioxidant activity. Usually, the results of DPPH assay were expressed in IC_{50} values. Concentration of the sample necessary to decrease initial concentration of DPPH• by 50% (IC_{50}) under the experimental condition was determined. Therefore, the lower value of IC_{50} indicates a higher antioxidant activity. All the extracts of various ratios showed excellent DPPH˙ radical scavenging activity. The best free radical scavenging activity is exhibited by PE: DA (1:0) which is comparable to the referred standard BHT. Among the ratios PE: DA (1:2) is found to have a lower IC50 value of 21. 82µg/ml followed by PE: DA (1:5) having a value of 22. 87µg/ml.

An inhibition rate of 78. 2% was found in PE: DA (1:0) and among the various ratios a good inhibition rate is given by PE: DA (1:2) which is also having a lower IC50 value and this indicates its good antioxidant capacity. Therefore, among the various ratios PE: DA (1:2) is found to have a good antioxidant capacity.

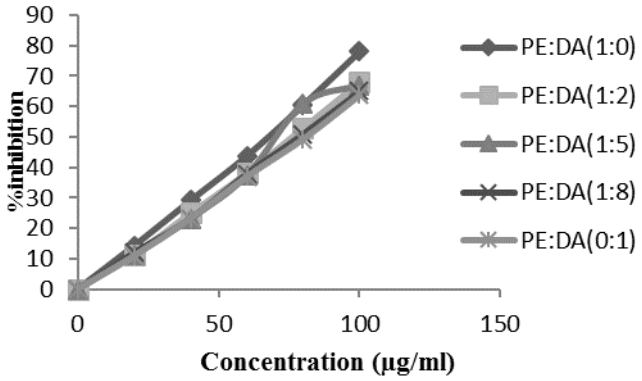

Figure 2: DPPH radical scavenging activity of various mixed ratios of PE: DA

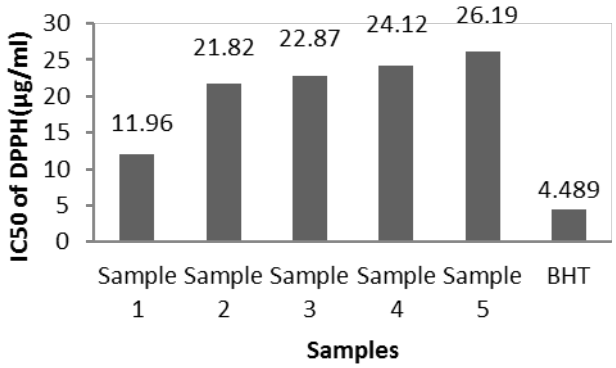

Figure 3: DPPH radical scavenging activity of different ratios of PE: DA

3. 3. 2 DPPH radical scavenging activity of various mixed ratios of MC: CE

The DPPH radical scavenging activities of different ratios of MC: CE are shown in Figure 4 and 5. The best free radical scavenging activity is exhibited by MC: CE (1:0) which is comparable to the referred standard BHT. Among the ratios MC: CE (1:2) is found to have a lower IC50 value of 22.39 µg/ml followed by MC: CE (1:5) having a value of 24.82µg/ml.

Lower IC50 value and a higher inhibition rate indicate a higher antioxidant activity. An inhibition rate of 79.2% was found in MC: CE (1:0) and among the various ratios a good inhibition rate is given by MC: CE (1:2) which is also having a lower IC_{50} value and this indicates its good antioxidant capacity. Therefore, among the various ratios MC: CE is found to have a good antioxidant capacity.

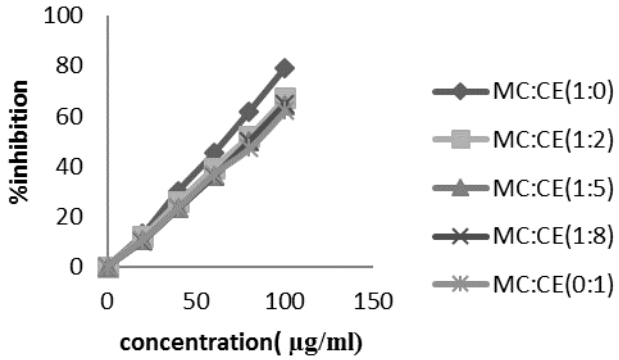

Figure 4: DPPH radical scavenging activity of various mixed ratios of MC: CE

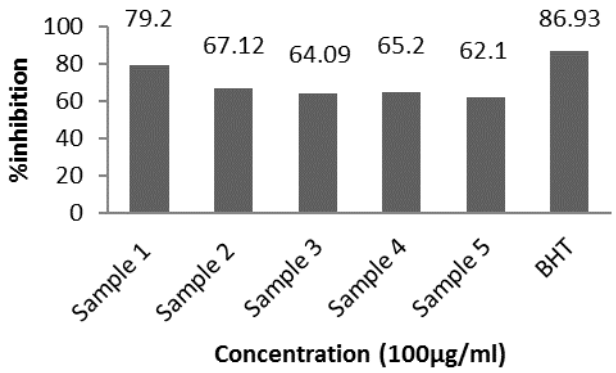

Figure 5: DPPH radical scavenging activity of different ratios of MC: CE

3. 3. 3 Metal chelating activity of various mixed ratios of PE: DA

The metal chelating activities of different ratios of PE: DA are shown in Figure 6. Metal chelating capacity was significant as they reduced the concentration of the catalyzing transition metal in lipid peroxidation (Duh *et al*., 1999). It was already reported that chelating agents which form σ- bonds with a metal, are effective as secondary antioxidants because they reduce the redox potential, thereby stabilizing the oxidized form of the metal ion (Gordon, 1990). Antioxidants inhibit interaction between metal and lipid through formation of insoluble metal complexes with ferrous ion. Hence the data obtained reveals that s all the extracts of various samples demonstrate an effective capacity for iron binding, suggesting that its action as antioxidant may be related to its iron binding capacity. All the sample extracts exhibited the ability to chelate metal ions. Among the different sample extracts, PE: DA (1: 0) shows an activity of (75. 9 %). Further, the activity decreased in methanol extract of various samples and among the various mixtures PE: DA (1: 2) exhibits an activity of (64. 26 %)

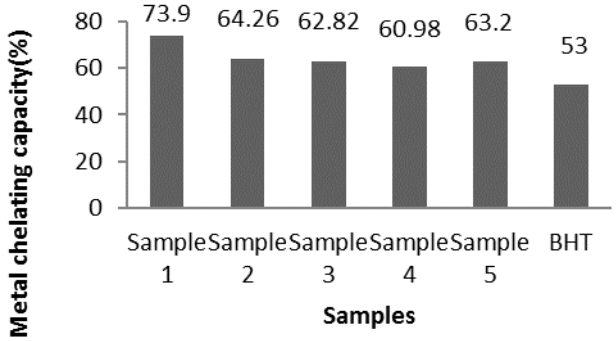

Figure 6: Metal chelating activity of various ratios of PE: DA

3. 3. 4 Metal chelating activity of various mixed ratios of MC: CE

The metal chelating activities of different ratios of MC: CE are shown in Figure 7. Iron is essential for life because it is required for oxygen transport, respiration, and activity of many enzymes. In complex systems, such as food and food preparations, various different mechanisms may contribute to oxidative processes, such as Fenton reaction, where transition metal ions play a vital role. Different reactive oxygen species might be generated and various target structures such as lipids, proteins, and carbohydrates, can be affected. Therefore, it is important to characterize the extracts by a variety of antioxidant assays (Halliwell B et al., 1997). The chelating effect on the ferrous ions by the various samples are shown in figure5. All the sample extracts exhibited the ability to chelate metal ions. Among the different sample extracts, MC: CE (1:0) shows an activity of (75. 9%). Further, the activity decreased in methanol extract of various samples and among the various mixtures MC: CE (1:2) exhibits an activity of (65. 21%). Chelating agents

are effective as secondary antioxidants because they reduce the redox potential thereby stabilizing the oxidized form of the metal ion (Gulcin I et al., 2007). The high contents of polyphenolic compounds present in the extracts should be able to chelate transition metals because of the high charge density of the phenoxide group generated on deprotonation (Hyder RC et al., 2001). The findings of the study established that the extracts could chelate irons and the values are substantial.

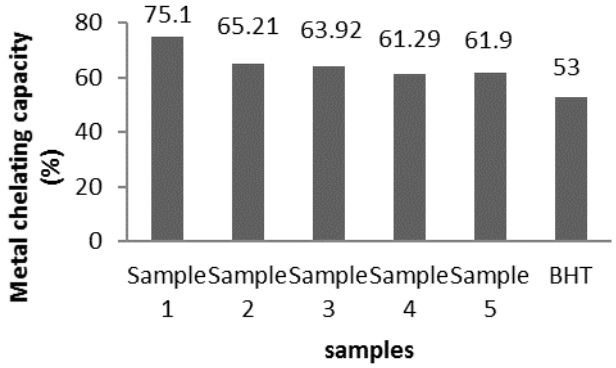

Figure 7: Metal chelating activity of various ratios of MC: CE

3. 3. 5 Phosphomolybdenum assay of different ratios of PE: DA

The phosphomolybenum assay of different ratios of PE: DA are shown in Figure 8**.** The phosphomolybdenum method is based on the reduction of Mo (VI) to Mo (V) by the antioxidant compounds and the formation of green phosphate/Mo(V) complex with the maximal absorption at 695 nm. Among the various extracts evaluated, the PE: DA (0:1) extract of Dioscorea alata alone had the strongest phosphomolybdenum reduction (298. 32). Among the various mixed ratios PE: DA (1: 8) shows the highest phosphomolybdenum reduction of (291. 36) followed by PE: DA (1:5), (288.79). Hydrogen/electron transfer from antioxidants to DPPH radical and Mo(VI) complex occur in the DPPH radical and phosphomolybdenum assays, respectively (Halliwell B, 2008).

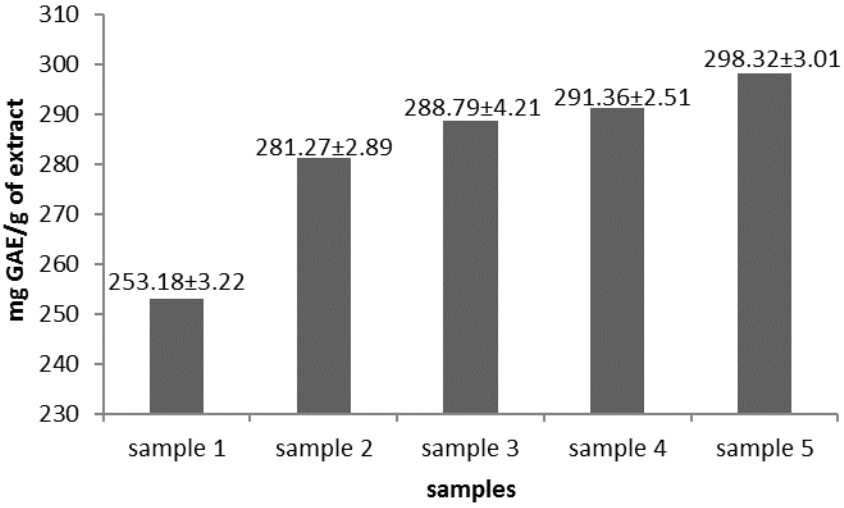

Figure 8: Phosphomolybdenum activity of various mixed ratios of PE: DA

3. 3. 6 Phosphomolybdenum assay of different ratios of MC: CE

Among the various extracts evaluated, the MC: CE (0:1) extract of had the strongest phosphomolybdenum reduction (292.93). Among the various mixed ratios shows the highest phosphomolybdenum reduction (284.8) followed by MC: CE (1:5) (281.8).

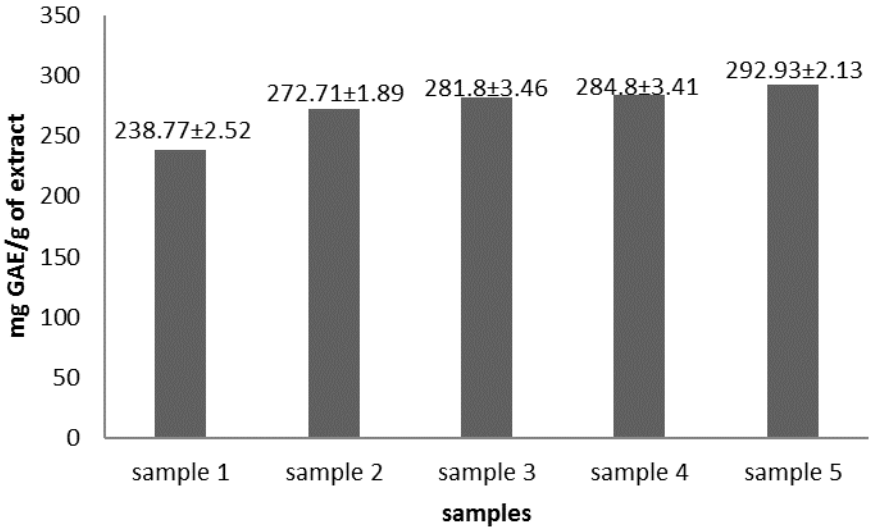

Figure 9: Phosphomolybdenum activity of various mixed ratios of ME: CE

3. 3. 7 Sample analysis of extruded product sample of PE: DA

The mass flow rate was found to be minimum in the range of 3.30g/s for the sample which was extruded at a temperature of 100˚C and 13% moisture. The bulk density of the MC: CE (1:8) (110˚C,13%) was found to be highest in the range of 0.8 g/100ml when compared to the other samples. Swelling power of MC: CE (1:8) (110˚C, 13%) was found to be highest and percent solubility was found to be highest in MC: CE (1:8) (100˚C, 13%)

3. 3. 8 Sample analysis of extruded product sample of MC: CE

The mass flow rate was found to be minimum in the range of 3.12g/s for the sample which was extruded at a temperature of 100˚C and 13% moisture. The minimum mass flow rate indicates faster extrusion. The variations in the mass flow rate of extrudate samples were very less, due to constant maintenance of barrel temperature as well as moisture content in the feed mixtures. The bulk density of the MC: CE (1:8) (110˚C,13%) was found to be highest in the range of 0.7 g/100ml when compared to the other samples. Swelling power of MC: CE (1:8) (100˚C,13%) was found to be highest

3. 4 Comparison of PE: DA and MC: CE

The results indicate that moisture content of PE: DA (1:8) showed a highest moisture content of 6.18% when compared to the other mixed ratios of PE: DA and moisture content of MC: CE (1:2) showed the highest moisture content of 5.38% when compared with the other mixed ratios of MC: CE and when comparing PE: DA (1:8) and MC: CE (1:8) the moisture content is less in MC: CE (1:8) and lesser moisture increases the shelf life of the mixture. PE: DA (1:8) was found to have an ash content of 4.38% which was higher when compared with other ratios of PE: DA. The ash content of MC: CE (1:8) was found to be 5.37% which is higher than that of the other samples of MC: CE and the ash content was high in MC: CE (1:8) when compared to PE: DA (1:8) and the ash content indicates the presence of minerals. Iron content of PE: DA (1:8) powder is reported to have highest iron content of value 0.51mg/100g than other samples of PE: DA (1:8) and iron content of MC: CE (1:8) was found to be 0.56mg/100g which was found to be the highest among all the mixed ratios of MC: CE (1:8) and the iron content of MC: CE (1:8) is higher than PE: DA (1:8). PE: DA (1:2) is found to have a highest calcium content of 20.18mg/100g. MC: CE (1:2) is found to have a calcium content of 21.1mg/100g and it was found to be the highest among the various mixed ratios of MC: CE (1:2) and MC: CE (1:2) has higher calcium content than PE: DA (1:2). Phosphorous content of PE: DA (1:8) was found to be 59.94mg/100mg which was higher when compared to the other samples of PE: DA. Phosphorous content MC: CE (1:8) is found to have significant amount of 51.3mg/100g which is found to be highest among the various mixed ratios of MC: CE. Phosphorous content of PE: DA (1:8) is higher than MC: CE (1:8).

From the results it was found that PE: DA (1:8) had the highest starch content of 5928.6mg/100g among the various mixed ratios of PE: DA and among the samples of MC: CE it was observed that MC: CE (1:8) had a starch content of 6278mg/100g. When the starch content of MC: CE and PE: DA where compared it was found that MC: CE (1:8) had a higher starch compared to PE: DA (1:8). The tannin content was highest in PE: DA (1:2) in the range of 0.45mg/100g among the mixed ratios of PE: DA and among the mixed

ratios of MC: CE, MC: CE (1:2) was found to have the highest tannin content of 0.68mg/100g. When the tannin content of PE: DA and MC: CE where compared it as found that MC: CE (1:2) has a higher tannin content when compared to PE: DA (1:2). The crude fat content was highest in PE: DA (1:2) in the range of 1.89% among the mixed ratios of PE: DA and among the mixed ratios of MC: CE, MC: CE (1:2) was found to have the highest crude fat content of 1.82%. When the crude fat content of PE: DA and MC: CE where compared it as found that MC: CE (1:2) has a lesser crude fiber content when compared to PE: DA (1:2). The crude protein content was highest in PE: DA (1:2) in the range of 17.16% among the mixed ratios of PE: DA and among the mixed ratios of MC: CE, MC: CE (1:2) was found to have the highest crude protein content of 12.69%. When the crude protein content of PE: DA and MC: CE where compared it as found that MC: CE (1:2) has a higher crude protein content when compared to PE: DA (1:2). The crude fiber content was highest in PE: DA (1:2) in the range of 1.78% among the mixed ratios of PE: DA and among the mixed ratios of MC: CE, MC: CE (1:2) was found to have the highest crude fiber content of 2.13%. When the crude fiber content of PE: DA and MC: CE where compared it as found that MC: CE (1:2) has a higher crude protein content when compared to PE: DA (1:2). The carbohydrate content was highest in PE: DA (1:8) in the range of 74.41 mg/100g among the mixed ratios of PE: DA and among the mixed ratios of MC: CE, MC: CE (1:8) was found to have the highest carbohydrate content of 87.21 mg/100g. When the carbohydrate content of PE: DA and MC: CE where compared it as found that MC: CE (1:8) has a higher carbohydrate content when compared to PE: DA (1:8).

In DPPH antioxidant assay among the ratios PE: DA (1:2) is found to have a lower IC_{50} value of 21.82µg/ml followed by PE: DA (1:5) having a value of 22.87µg/ml. A good inhibition rate is given by PE: DA (1:2) which is also having a lower IC50 value. Among the ratios MC: CE (1:2) is found to have a lower IC50 value of 22.39µg/ml followed by MC: CE (1:5) having a value of 24.82µg/ml. Among the various ratios a good inhibition rate is given by MC: CE (1:2) which is also having a lower IC50 value. PE: DA (1:2) is having a lower IC_{50} than MC: CE (1:2). In metal chelating assay among the different sample extracts, PE: DA (1:2) exhibits an activity of (64.26 %) which is lesser which compared with MC: CE (1:2) which exhibits an activity of (65.21 %). PE: DA (1:8) shows the highest phosphomolybdenum reduction of (291.36) when compared with MC: CE (284.8).

The mass flow rate of PE: DA was highest in PE: DA (1:8) (110˚C,12 %) in the range of 3.42g/s among the various mixed ratios of PE: DA and among the mixed ratios of MC: CE (1:8) (110˚C,12 %) was found to have the highest mass flow rate of 3.37g/s. When ME: CE and PE: DA where compared it was found that PE: DA (1:8) (110˚C,12 %) was the highest. It was observed that PE: DA (1:8) (110˚C,13 %) had the highest bulk density of 0.8g/100ml among the various mixed ratios of PE: DA and among the mixed ratios of MC: CE, MC: CE (1:8) (110˚C,12 %) was found to have the highest bulk density of 0.7g/100ml. When both MC: CE and PE: DA are compared it was observed PE: DA (110˚C,13 %) had a higher bulk density. The swelling power of PE: DA (1:8) (110˚C,13 %) was found to be 5.86 g/g and that of MC: CE (1:8) (110˚C,13 %) is 5.87g/g which were the highest among the various mixed ratios of PE: DA and MC: C. When PE: DA and MC: CE are compared it was observed that both the samples had equal swelling power. The percentage solubility of PE: DA (1:8) (100˚C,13 %) was found to be 0.03% and that of MC: CE (1:8) (110˚C,12 %) is 0.035% which were the highest among the various mixed ratios of PE: DA and MC: CE. When PE: DA and MC: CE are compared it was observed that both the samples had equal swelling power.

4. CONCLUSION

From the results obtained from this analysis of various mixtures of PE: DA and MC: CE PE: DA (1:8) and MC: CE (1:8) was found to have a significant amount of moisture content, ash content, iron, phosphorous, starch and crude protein, crude fat, carbohydrate, DPPH antioxidant activity, metal chelating and Phosphomolybdenum assay when compared with other mixed ratios of PE: DA and MC: CE and that was used for the development of extruded product and the developed product using PE: DA (1:8) and MC: CE (1:8) can be employed as a good nutritional and antioxidant extruded product among all the other ratios.

5. REFERENCES

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