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DISTRIBUTION OF ASH, CALCIUM AND PHOSPHORUS IN THE BYPRODUCTS OF GREEN CROP FRACTIONATION

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Abstract: The Green Crop Fractionation (GCF) process results in three types of products: i) The pressed crop residue (PC) left after extraction of juice, which is suitable for animal nutrition : ii) the leaf protein concentrate (LPC), suitable for human nutrition, and iii) the deproteinised juice (DPJ), which is a byproduct. While recommending foliage of any plant species for fractionation and LP production, it is important to undertake studies on distribution of crop nutrients in PC, LPC, and DPJ. Such type of studies help in producing food and feed grade products of desirable quality. Taking this in view, foliages of nine dark green vegetables (DGLVs) were fractionated. The distribution of ash, calcium (Ca) and Phosphorus (P) in the three products of fractionation (PC, LPC, DPJ) were studied. It has been observed that the essential minerals remain un-extracted in the pressed crop, which could be used as a feed for cattle. It was also observed that large proportion of ash and useful nutrients like calcium and phosphorus are lost in the DPJ fraction, which is considered as a byproduct of Green Crop Fractionation. Present investigation reports the distribution of plant nutrients (dry matter, ash, Calcium and Phosphorus) in leaf juice, pressed crop, LPC, and DPJ obtained during fractionation of 8 common vegetables of the region and for comparison in fodder crop lucerne also.

Key Words: Pressed Crop (PC); Juice; DPJ; Ash; Calcium; Phosphorus.

INTRODUCTION

The objective of present investigation was to find out nutrient status and its relative distribution in percent of each fractionated byproduct viz.,pulp, pressed crop (PC) or fibre, Juice, (Sayyed and Mungikar, 2003), LPC (Sayyed, 2010; 2011, Iliyas and Badar, 2010 a and b) and DPJ (Sayyed and Mungikar, 2005; Josephine and Sayyed , 2005; Sayyed, 2013) of different crops. The byproduct DPJ was used to investigate as the fertilizer for plants or medium for microbial growth (Jadhav, 1997).

MATERIALS AND METHODS

Green leaves of 9 crops viz., cauliflower (*Brassica oleracia L. cv .botrytis*), spinach *(Spinacia oleracia L.)*, fenugreek (*Trigonella foenicum graceum L.)*, radish (*Raphanus sativus L.)* cabbage (*Brassica oleracia L. Var capitata), Atriplex hortensis L.*, coriander (*Coriandrum sativum L.*), dill (Anathum *graveolens L.)*, and Lucerne (Medicago *sativa L.*) were obtained from either vegetable market or from the Babasaheb Ambedkar Marathwada University Botanical Garden, Aurangabad, wherein they were cultivated using recommended cultural practices and harvested at a pre flowering stage.

The fresh vegetation was washed with water to remove the adhering dust and mud particles .The excess of water was removed manually before fractionation. Three kg samples of green foliage were pulped on IBP pulper (Davys and Pirie, 1969). A sample of pulped fresh crop was taken for analysis. 900 gm of pulp was pressed on IBP bench press (Davys et.al, 1969) for 10 minutes. The amount of juice released due to the pressing was measured and a sample was taken for analysis.

A known volume of juice was slowly added to about 20 ml boiling water and heated to over 95°C for the preparation of leaf Protein Concentrate (LPC). The protein concentrate (curd), resulting due to the heating of juice, was then separated from deproteinised juice (DPJ) by filtration through cotton cloth. The amount of LPC and DPJ, obtained due to heating of known volume of juice were measured and the samples were taken for analysis. Each crop was fractionated into PC, LPC, and DPJ twice and duplicate samples for each processing, were taken for the analysis.

The samples of pulped fresh crop, pressed crop, juice, LPC and DPJ were dried in an oven at 95 ± 5 ° C for the determination of dry matter (DM). The dried samples were ground to a fine powder and stored in plastic containers for further analysis.

A .O. A. C. (1970) methods were followed for the determination of ash and calcium (Ca) contents. A method of Fiske and Subba Rao (1925) described by Oser (1979) was followed for the determination of inorganic phosphorus (P).

The amounts of dry matter, ash, calcium, phosphorus in one kg of fresh crop, and in the fractionation products resulting from it, was calculated. For this purpose the volume/weight of each fraction obtained after processing of 1 kg fresh crop and their chemical composition were considered. The relative distribution of each constituent was then calculated.

RESULT

The ash, Ca and P content in fresh and pressed foliages of 9 crops is given in table 1, 2 and 3. Leaves of *Anathum* contained maximum ash. Spinach contained maximum calcium, while P content was maximum in cauliflower. Among all species, lucerne was nutritionally inferior with 0.32 % Ca, while coriander contained 8.70 % ash and 0.15 % P (all on dry matter basis).

The fresh weight of all species decreased after pressing, due to the removal of moisture in juice. The % DM in pressed crop was with lower values of ash, Ca, and P

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(on DM basis); these nutrients were removed in juice along with moisture.

Fresh juice extracted from lucerne, coriander, fenugreek, cabbage, *Anathum,* cauliflower, spinach, *Atriplex,* and radish contained respectively 25.6, 15.7, 20.8, 29.8, 21.5, 15.9, 12.5, 16.0 and 24.7 % ash on DM basis. The amount of Ca and P in juice DM varied with species; coriander juice gave maximum value for Ca, while that of lucerne for the Phosphorus content. The overall results presented in table 1, 2 and 3 indicate that a part of the crop nutrients were extracted in juice during fractionation.

The chemical composition of DPJ and LPC resulting from fractionation of juice samples of the 9 crops is given. The yield of deproteinised juice (DPJ) or whey per unit weight of green foliage, was always more than that of leaf protein concentrate (LPC). DPJ contained large proportions of ash as well as Ca and P.In view of P content of DPJ, its recycling into the soil as a fertilizer source and as a medium for microbes would be much profitable (Jadhav, 1998; Jadhav and Mungikar., 2005). The LPC was prepared by heating juice to 95°C. The proteins in fresh juice was coagulated by heat and separated by filtration (Jadhav. R.K., 2001).

Discussion

The typical protein concentrate prepared from leaf juice contains (on DM basis) around 5% ash (Byers, 1983). An International Biological Programe (IBP) technical group suggested maximum ash content of 3% (on DM basis) in LPC, if it is used for human consumption (Pirie, 1971). However, almost all samples during present study were rich in ash content. The main source of ash is in the dust or mud adhering to the harvested crop, much of which can be removed if the crop is thoroughly washed before pulping. Other obvious source of ash is the high silica (acid insoluble ash) content of some species. Pirie (1978) of the opinion that silica is probably harmless constituent of leaf protein.

Subba Rau *et al.,* (1972) reported that the LPC with large proportion of ash is less digestible. The ash content in the samples, prepared during present investigation, was too high ranging between 3.47 and 21.0% (on DM basis). It is worth finding out whether high proportion of ash in the concentrates was due to bad preparative technique or the type of species used. Leaf protein concentrate from spinach was with maximum Ca, while that with *Atriplex* showed appreciable amount of phosphorus.

The distribution of DM and Nitrogen (N) content in various fractionation products was studied previously (Jadhav, 2014). Out of the total crop dry matter pressed, from 62 to 88 % remained un-extracted in pressed crop (PC). Major amount of the DM extracted in juice was removed in DPJ and a part was recovered in LPC.

From 16 to 61 % of ash was extractable in juice (Table 1.). However, relatively small amount of extracted ash was recovered by LPC: a large portion of it was released in DPJ fraction. The LPC could recover from 1.6 to 14.5 % ash present in the crop. The extractability of calcium in juice and its recovery in protein concentrate varied widely (Table 2). In cabbage, only 3.5 % of total calcium got incorporated in LPC, while in case of Fenugreek, this value exceeded to as high as 14.1 %. From 13 to 50 % of phosphorus present in whole crop was extractable and from 3 to 15% was recoverable in protein concentrate (Table 3).

Table 1: Distribution of Ash from 1 kg fresh vegetation of 9 crops in various products of Fractionation.

Crop	Ash, g.				
	Fresh Crop	Pressed Crop	Juice	Deproteinised Juice (DPJ)	Leaf Protein Concentrate (LPC)
Lucerne	35.52 (100)	24.73 (69.62)	10.83 (30.49)	9.04 (25.45)	1.80 (5.07)
Coriander	14.79 (100)	9.57 (64.70)	5.23 (35.36)	4.70 (31.78)	0.54 (3.65)
Fenugreek	17.40 (100)	10.16 (58.39)	7.21 (41.44)	4.69 (26.95)	2.52 (14.48)
Cabbage	20.83 (100)	16.52 (79.30)	4.24 (20.36)	3.84 (18.43)	0.40 (1.92)
Anathum	23.11 (100)	14.65 (63.39)	8.46 (36.61)	8.10 (35.05)	0.36 (1.56)
Cauliflower	17.07 (100)	12.28 (71.94)	4.78 (28.00)	2.67 (15.64)	2.09 (12.24)
Spinach	19.44 (100)	16.16 (83.12)	3.25 (16.72)	1.30 (6.69)	1.95 (10.03)
Atriplex	12.69 (100)	7.93 (62.50)	4.73 (37.27)	3.70 (29.16)	1.03 (8.11)
Raddish	12.84 (100)	4.97 (38.74)	7.84 (61.06)	7.35 (57.24)	0.49 (3.81)

Values in parenthesis indicates relative distribution.

Table 2: Distribution of calcium (Ca) from 1 kg fresh vegetation of 9 crops in various products of fractionation

Crop	Calcium, g.				
	Fresh crop	Pressed Crop	Juice	Deproteinised Juice (DPJ)	Leaf Protein Concentrate (LPC)
Lucerne	0.768 (100)	0.554 (72.4)	0.220 (28.65)	0.161 (20.96)	0.060 (7.81)
Coriander	1.122 (100)	0.724 (64.53)	0.397 (35.38)	0.339 (30.21)	0.056 (4.99)
Fenugreek	0.546 (100)	0.360 ((65.93)	0.184 (37.70)	0.106 (19.41)	0.077 (14.10)
Cabbage	0.880 (100)	0.727 (82.61)	0.158 (17.95)	0.127 (14.43)	0.031 (3.52)
Anathum	0.698 (100)	0.467 (66.91)	0.228 (32.66)	0.146 (20.92)	0.082 (11.75)
Cauliflower	0.884 (100)	0.568 (64.25)	0.315 (35.63)	0.233 (26.36)	0.081 (9.16)
Spinach	1.079 (100)	0.91 (84.52)	0.166 (15.38)	0.052 (4.82)	0.113 (10.47)
Atriplex	0.468 (100)	0.351 (75)	0.121 (25.85)	0.069 (14.74)	0.052 (11.11)
Raddish	0.884 (100)	0.553 (62.56)	0.330 (37.33)	0.282 (31.90)	0.047 (5.32)

Value in parenthesis indicate relative distribution.

Table 3: Distribution of Phosphorus (P) from 1 kg fresh vegetation of 9 crops in various products of fractionation.

Crop	Phosphorus, g.				
	Fresh Crop	Pressed crop	Juice	Deproteinised Juice (DPJ)	Leaf protein Concentrate (LPC)
Lucerne	0.576 (100)	0.376 (65.28)	0.195 (33.85)	0.153 (27)	0.050 (8.68)
Coriander	0.255 (100)	0.191 (74.90)	0.063 (24.71)	0.047 (18.43)	0.017 (6.67)
Fenugreek	0.254 (100)	0.157 (61.71)	0.101 (39.76)	0.069 (27.16)	0.017 (10.63)
Cabbage	0.211 (100)	0.187 (88.63)	0.028 (13.27)	0.015 (7.10)	0.007 (3.32)
Anathum	0.299 (100)	0.112 (48.91)	0.114 (49.78)	0.090 (39.30)	0.027 (11.79)
Cauliflower	0.281 (100)	0.231 (82.21)	0.051 (18.15)	0.036 (12.81)	0.016 (5.69)
Spinach	0.149 (100)	0.107 (71.81)	0.042 (28.19)	0.025 (16.78)	0.017 (11.41)
Atriplex	0.171 (100)	0.091 (53.22)	0.083 (48.54)	0.060 (35.08)	0.021 (12.28)
Radish	0.179 (100)	0.106 (59.22)	0.073 (40.78)	0.047 (26.26)	0.027 (15.08)

Value in parenthesis indicate relative distribution.

The understanding of crop nutrient composition and distribution of individual nutrient in PC, LPC and DPJ is important in developing a fractionation process. In view of this, the present investigation was undertaken with 9 crops, earlier found suitable for LP production. The results presented may be summarized as follows:

The present crop residue left after the release of juice is a low moisture (or high dry matter) product. Chemical composition of pressed crop depends on the amounts of various chemical constituents present in the whole crop and their extractabilities in juice. Mungikar and Joshi (1983) pointed out that moisture content of crop dictate, to a large extent, the extractability of protein in juice: higher the moisture content in fresh crop, more will be the juice extracted along with crop nutrients.

The juice extracted, due to the pressing of whole crop, is a high protein fraction. Along with moisture and protein, large amounts of inorganic constituents are also extracted in this fraction. The nutrient composition of juice (on DM basis) revealed its superiority over the composition of whole crop.

Conclusion

The distribution of DM, ash, Ca and P in PC, LPC and DPJ have been summarized in figures 1-3. The illustrations represent preparation of LPC by heat coagulation. The figures clearly indicate that these nutrients are not uniformly distributed among the three fractionation products. Major part of the inorganic constituents were however, lost in deproteinised juice.

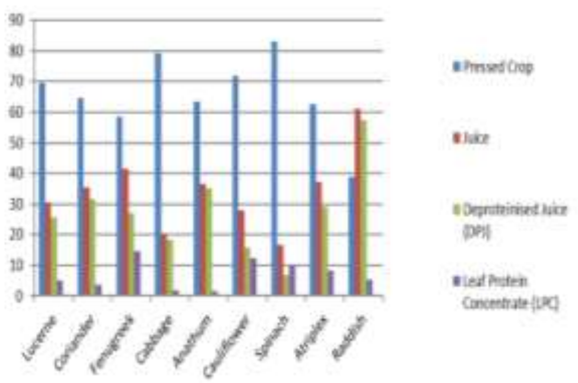

Figure 1: Distribution of Ash from 1 kg of fresh vegetation of 9 crops in various products of fractionation

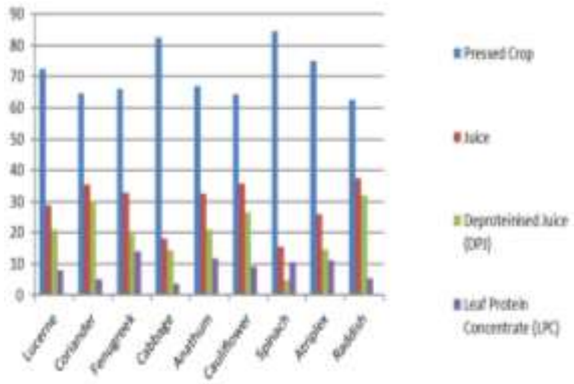

Figure 2: Distribution of Calcium (Ca) from 1 kg of fresh vegetation of 9 crops in various products of fractionation.

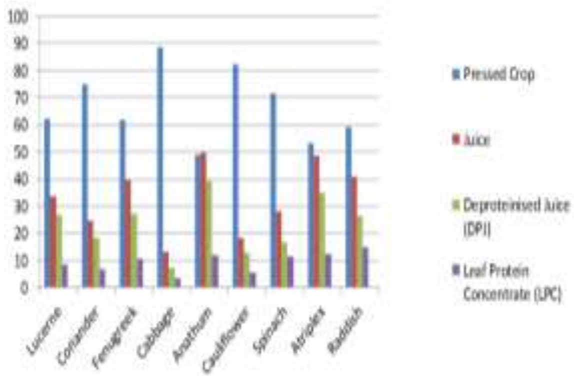

Figure 3: Distribution of Phosphorus (P) from 1 kg of fresh vegetation of 9 crops in various products of fractionation.

The results indicate that the pattern of distribution of nutrients (ash, Ca, and P) in various fractionation products varied with species. However, large amounts of crop nutrients were removed in deproteinised juice showed in figs. 1-3 (Mungikar, 1988).

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