ISSN 0975 – 2595

PRAJÑĀ

Volume 18, 2010

Journal of Pure and Applied Sciences

SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR
Gujarat – 388 120, INDIA
www.spuvvn.edu

PRAJÑĀ - Journal of Pure and Applied Sciences, Vol. 18: 50 - 53 (2010)
ISSN 0975 - 2595

NON-STRUCTURAL CARBOHYDRATE, PROTEIN AND MINERALS FROM SOME NON-CONVENTIONAL SEEDS OF SEMI-ARID REGION OF GUJARAT

Manisha Sharma* and Bharat Pandit[1]

Directorate of Medicinal and Aromatic Plants Research, Boriavi 387310, Gujarat
[1]Department of Life Sciences, Bhavnagar University, Bhavnagar 364 002, Gujarat

ABSTRACT

Seeds of eleven non conventional plants were selected for the study on the basis of its frequent use by tribal and rural community of semi-arid region of Gujarat. All reported seeds were analyzed for its non structural carbohydrate, protein and minerals like Ca, Mg, Na, K, and Fe. Total carbohydrate ranged from 0.71-33.07 mg/g in *Paspalum scrobiculatum* L and *Citrullus lanatus* respectively. Total protein was high in seeds of *Cucumis melo* (62.11 mg/g) and was low in *Paspalum scrobiculatum* (8.79 mg/g). Ca was high in *H. vulgare (*8.0 mg/g) and was low in *Seteria italica* (4.12 mg/g), Mg was high in *Echinocloa colonum* (36.24 mg/g) and was low in *Echinocloa frumantacea* (20.54 mg/g). Seeds of *Nymphaea pubescens* contained highest Na i.e. 0.29 mg/g amongst all reported plant species. While K was high in seeds of *Paspalum scrobiculatum* (0.8 mg/g) and was low in *Echinocloa colonum* (0.04 mg/g). Seeds of all reported plant species contained very low amount of Fe.

Key words*: minerals, nonstructural carbohydrates,non-conventional plants, protein*

INTRODUCTION

According to WHF, 2005 [19] tropical countries are blessed with a diversity of foodstuffs which play a basic role in nutrition and healthy body development. Unfortunately an estimated 789 million people in developing countries still suffer from malnutrition especially infants and children of rural areas. Malnutrition can be tremendously reduced with an increase use of foods rich in energy, proteins, iron and vitamin A most especially those from the rural and tribal environment. Owing to diverse agroclimatic conditions India is endowed with a wide variety of plants both wild growing and domesticated, which contribute to the diet of its people. Depending upon certain factors like, availability, socio-economic conditions, tradition, taste and culture, some of these foods are regularly consumed in the form of staple foods whereas other are taken less frequently or on certain occasions are known as indigenous plants, under-utilized plants, famine food plants or non-conventional plants [4 and 9]. These non-conventional plants are valuable sources of nutrients in rural areas where exotic species are limited and thus contributes substantially to protein, minerals and vitamin intakes [11]. Tribal people use major component of diets providing the bulk of nutritional requirements. Which posses constitutes essential components of the meal by contributing protein, vitamins, iron, fiber, ascorbic acid and other minerals which are usually in short supply in the diet of urban people [12]. Most of the non-conventional plants are weedy, semi cultivated plant species which require very little input and management. Though they are very important are neglected by scientific and developmental system. Tribal people use most of these plants without any scientific knowledge and its nutritional value which may ever cause some health problem and malnutrition. Hence, scientific study was needed to enlighten nutrient contents of non-conventional plant foods to overcome malnutrition and therefore the study was conducted with an objective to analyze and quantify nutrient composition available in seeds of twelve non-conventional plants found in semi-arid region of Gujarat.

Nutritional contribution and nutritive value of most common foods have been extensively studied but, there is practically no information on nutritive value of some of these non-conventional foods which may contribute significant nutrient intake of local population [4].

* Corresponding author: dr.manishatsharma@gmail.com

MATERIAL AND METHODS

Source of plant material

The seeds of the total eleven plant species were taken to carry out this study (2004-06) for which detail is mentioned in Table 1. They were collected from the field. Seeds of selected plant species considered in the present study are primarily used in form of flour or in raw state to mix with other flour or cook separately to prepare different dishes respectively. Identification of collected plants was done by local flora [16]. Uses of the plants were recognized by folklore and by book [1] and from Freedman's "Famine Food" database (2003).

Table - 1 List of the selected plant species

Sr. no.	Scientific name	Family
1.	*Amaranthus peniculatum* L.	Amaranthaceae
2	*Citrullus lanatus* Thunb, Mat and NaK.	Cucurbitaceae
3.	*Cucumis melo* L.	Cucurbitaceae
4.	*Carvia callosa* (Nees.) Bremek	Acanthaceae
5.	*Eleusine coracana* L. Gaertn.	Poaceae
6.	*Echinocloa frumantacea* Link.	Poaceae
7.	*Echinocloa colonum* L., Link.	Poaceae
8.	*Hordeum vulgare* L.	Poaceae
9.	*Nymphaea pubescens* Willd., Hk. F and Th.	Nymphaeaceae
10.	*Paspalum scrobiculatum* L.	Poaceae
11.	*Seteria italica* L., P. Beauv	Poaceae

All collected seed samples were taken to the laboratory in dried form. They were ground, sieved through 60 mm meshes and stored in air-tight polythene bags under room temperature condition for further biochemical analysis.

Analysis of total carbohydrate was done following method given by Mahadevan and Sridhar [10] and was calculated by addition of total sugar and total starch.

Analysis of total sugar was done following Nelson's method [15]. Procedure for analyzing reducing sugar was same as total sugar without hydrolysis and neutralization following Nelson's method [15]. Non-reducing sugar was analyzed by subtraction of reducing sugar from total sugar [10]. Total starch was calculated following conversion factor of 0.9 to total sugar [10]. Total protein analysis was done following Lowry's method [8].

Mineral analysis

Analysis of minerals like Ca and Mg was done following method of Trivedi and Goel [18]; Na and K was done following Flame photometer method and Fe by AOAC manual [2]

Sample preparation for minerals was done by tri-acid digestion method following Trivedi and Goel [18].

Statistical analysis

All tests were performed in five replicates and statistical analysis was carried out using statistical software MSTAT 4.0 C package for computers (Michigan State University, USA) software following the method of Gomez and Gomez [5].

RESULTS AND DISCUSSION

According to Recommended Dietary Allowance (RDA) minimum 100 gm carbohydrate is required for body to perform normal functions. Highest carbohydrate was recorded in seeds of *C. lanatus* (table 2) but the recorded value is lower than reported by Gupta and Kanodia (40 mg g^{-1}) [6] and other conventional seeds like wheat (626 mg g^{-1}), pearl millet (675 mg g^{-1}) and rice (750 mg g-1) [3, 13]. Seeds of *A. peniculatum* possess second highest value of carbohydrate, which was lower than seeds of *A. gangaticus* (70.3 mg g^{-1}) reported by Katewa [7]. Recorded value was lower than reported by Aykroyd *et al*. [3 and 17] i.e. 62.7 g g^{-100}. Recorded value of carbohydrate content of *Citrullus lanatus* was lower than reported elsewhere [17] i.e. 45 mg g^{-1}. The seeds are eaten as appetizer. They are roasted, ground and added to sauces and soups to enrich their flavor and consistency. Recorded value of carbohydrate content of *H. vulgare* was higher than reported elsewhere [17] i.e. 6.3 mg g^{-1}. The All India Co-Ordinate Barley Improvement Project has released a number of improved varieties of barley which may be more nutritious than the wild plant. Seeds of remaining plants species possess moderate to low carbohydrate contents but can incorporate in the diet to improve quantity and quality of food during famine. Protein content in seeds of reported plant species is in good proportion. Seeds of *C. melo* possess highest protein content amongst all reported plant species (Fig. 1), which is higher than rice (50 mg g^{-1}) and was close to bengal gram (70 mg g^{-1}), blak gram (78 mg g^{-1}) and green gram (75 mg g^{-1}) [7] In Rajasthan during scarcity dried fruit rind and seeds are used in curries [17]. *C. lanatus* possess second high protein content which is close to rice [13]. Recoded value of protein from *C. lanatus* was higher than reported in The Wealth of India [17] i.e. 19.7 mg g^{-1}. The seeds are used as a protein supplements in Nigeria. They are parched and eaten with other grains [17]. Protein content of *E. coracana* was lower than its other improved varieties like JNR 852 and JNR 981 i.e 42 and 39 mg g^{-1}. The grain of *E. frumantacea* contain higher protein content than reported in The Wealth of India [17] i.e. 9.6 mg g^{-1}. Protein content of *S. italica* was lower than reported elsewhere (12.3 mg g^{-1}) [17]. Remaining plant species contain moderate to low protein content.

Ca is major constituent of bones and teeth together with phosphorus. Result reveled that all reported plant species supplies excellent quantity of Ca (table 3), which is higher than conventional grain like wheat (0.48 mg g^{-1}), rice (0.1 mg g^{-1}), pearl millet (0.26 mg g^{-1}) and pulses like Bengal gram (2.02 mg g^{-1}) and Soya bean (3.02 mg g^{-1}) [13]. Ca content of *A. paniculatum* was higher than Aykroyd *et al.* [3] and [17] i.e. 2.2 mg g^{-1}. Ca content of *C. lanatus* was also higher than reported by Aykroyd et al. [3] and [17] i.e. 1 mg g^{-1}. Ca content of *E. frumantacea* was lower than reported by Aykroyd *et al.* [3] i.e. 22 mg g^{-1}. Seeds of *S. italic* contain higher Ca content than reported by Aykroyd *et al.* [3] i.e. 3.1 mg g^{-1}. Mg content was also very high in seeds of reported plant species (Table 3) than conventional grain. Mg plays very important role in human immune system. It is required in plasma and extracellular system. It is required in many enzyme-catalyzed reactions; especially those in which nucleotides participate where the reaction species is the magnesium salt e.g. Mg ATP-2. Lack of Mg is associated with abnormal irritability of muscles and convulsions and excess Mg with the central nervous system. According to Narasinga *et al*, [14] RDA of Mg for man and woman is 400 mg day^{-1}, hence, results revealed that all reported plant species fulfills the same if taken in proper amount. There are no RDA standards for minerals like Na and K, because requirement of both of these element is fulfills by common salts in food. But person who do rigorous exercise or work in the hot place and during hot season, one who perspires profusely extra amount of salt is required. Its deficiency may cause cramps of muscles, headache, tiredness and sickness. Seeds of *N. pubescens* possess highest Na amongst all reported plant species (table 3). Which is closer to wheat (0.2 mg g-1) and higher than pearl millet (0.15 mg g^{-1}), maize (0.16 mg g^{-1}) and barley (0.11 mg g^{-1}) but it is lower than rice (0.8 mg g^{-1}) [3]. Na of *S. italica* was lower than reported elsewhere (4.4 mg g^{-1}) [3 and 17].

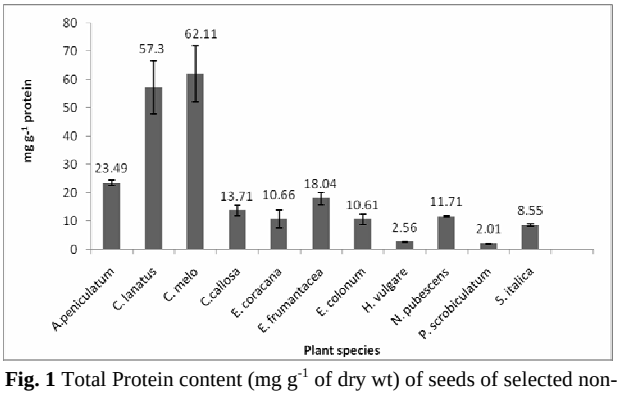

Fig. 1 Total Protein content (mg g^{-1} of dry wt) of seeds of selected non-conventional plants. (Each data is a mean n=5 ± signifies SD)

K was high in seeds of *P. scrobiculatum* amongst all reported plant species (table 3), but it was higher than reported by Katewa [7] i.e. 0.04 mg g^{-1}. Reported all plant species possess low iron content but can incorporate in diet by mixing with other grain or pulses to improve quantity and taste.

Amaranthus seeds are highly nutritious and combination of seeds with other grains gives an excellent protein content, batter than milk. The protein and Ca content of *E. colonum* is greater than other major cereals. Seeds of *Citrullus lanatus* and *Cucumis melo* provides excellent source of protein and major minerals. Seeds of *N. pubescens* eaten in times of scarcity by mixing with other grains. But it produce toxic effects when consumed in excessive quantity [17]. The grain of *P. scrobiculatum* because of low carbohydrate content was useful

Table - 2 Nonstructural carbohydrate contents (mg g^{-1} of dry weight) of seeds of selected non-conventional plants.

No.	Plant species	Total sugar (mg g^{-1})	Reducing sugar (mg g^{-1})	Non-reducing sugar (mg g^{-1})	Total starch (mg g^{-1})	Total Carbohydrate (mg g^{-1})
1.	*A. peniculatum*	12.58±0.78	0.39±0.02	12.19±0.75	11.33±0.70	23.91±1.48
2.	*C. lanatus*	17.41±0.12	10.64±0.23	6.69±0.13	15.66±0.11	33.07±0.23
3.	*C. melo*	10.37±0.23	3.24±0.07	7.13±0.18	9.33±0.20	19.70±0.44
4.	*C. callosa*	5.18±0.27	0.47±0.03	4.71±0.26	4.66±0.24	9.84±0.52
5.	*E. coracana*	1.33±0.12	0.23±0.01	1.25±0.14	1.33±0.11	2.8±0.23
6.	*E. frumantacea*	6.67±0.1	0.63±0.1	6.83±0.12	7.50±0.12	14.18±0.12
7.	*E. colonum*	8.21±0.4	3.23±0.09	4.99±0.49	7.39±0.36	15.60±0.77
8.	*H. vulgare*	7.46±0.67	0.63±0.02	6.83±0.68	6.71±0.60	14.18±1.27
9.	*N. pubescens*	4.00±0.08	2.37±0.12	1.63±0.04	3.6±0.07	7.60±0.16
10.	*P. scrobiculatum*	0.37±0.07	0.19±0.004	0.18±0.07	0.33±0.06	0.71±0.13
11.	*S. italica*	3.93±0.06	0.75±0.04	3.18±0.02	3.53±0.05	7.46±0.12

Each data is a mean n=5 ± signifies SD

Table - 3 Minerals contents (mg g^{-1} of dry weight) of seeds of selected non-conventional plants.

Plant species	Ca (mg g^{-1})	Mg (mg g^{-1})	Na (mg g^{-1})	K (mg g^{-1})	Fe (mg $100g^{-1}$)
A. peniculatum	5.6±0.10	25.36±0.10	0.006±0.002	0.34±0.02	0.165±0.002
C. lanatus	4.66±0.41	27.62±0.45	0.009±0.002	0.41±0.11	0.009±0.003
C. melo	7.12±1.04	21.06±0.51	0.006±0.002	0.33±0.03	0.007±0.002
C. callosa	4.56±0.32	25.26±0.09	0.073±0.004	0.38± 0.02	0.019±0.002
E. coracana	7.26±0.20	23.33±0.35	0.005±0.002	0.34±0.04	0.319±0.002
E. frumantacea	5.55±0.29	20.54±0.28	0.0063±0.002	0.21±0.01	0.074±0.002
E. colonum	6.48±0.31	36.24±0.25	0.004±0.002	0.04±0.01	0.162±0.001
H. vulgare	8.0±0.2	23.38±0.02	0.004±0.002	0.28±0.02	0.013±0.003
N. pubescens	7.21±0.11	24.34±0.68	0.29±0.02	0.48±0.005	0.074±0.004
P. scrobiculatum	5.66±0.23	24.37±0.88	0.007±0.001	0.8±0.02	0.044±0.002
S. italica	4.12±0.10	23.48±0.47	0.0056±0.002	0.25±0.01	0.127±0.001

Each data is a mean n=5 ± signifies SD

to diabetic patient and for calorie conscious people, and used as substitute of rice. The grains have often been reported to cause poisoning of men and animal when used as a food. Storage of grain over a number of years is said to diminish the poisonous properties [17].

CONCLUSION

Study revealed that seeds of *Amaranthus peniculatum, Citrullus lanatus Cucumis melo, Echinocloa frumantacea, Echinocloa colonum* and *Hordeum vulgare* are rich in carbohydrate, while seeds of all plant species are rich in protein, Ca, and Mg. Seeds of *Nymphaea pubescens* and *Carvia callosa* rich in Na and K but all species contain very low amount of Fe. Study also revealed that if reported all species incorporated in diet, person can overcome from malnutrition and other health problems.

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Volume 18 **December 2010**

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