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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Proximate Analysis of *Parinari curatellifolia* Fruit Pulp of Fruit from Parts of Harare and a Rural Area in Zimbabwe

C. Benhura[1], M.A.N. Benhura[2], M. Muchuweti[2], S.F. Nyagura[1] and P.E. Gombiro[1]
[1]Institute of Food, Nutrition and Family Sciences, University of Zimbabwe, Harare, Zimbabwe
[2]Department of Biochemistry, University of Zimbabwe, Harare, Zimbabwe

Abstract: *Parinari curatellifolia* fruit pulp for fruit collected from Harare and Mahusekwa was analysed for dry matter, mineral ash, crude protein, crude fat and crude fibre. The results for samples from Harare suburbs (CR, GR and PR) were; dry matter (27±0 to 34.5±0.4%, fresh weight), mineral ash (1.1±0 to 1.5±0.2% dry weight, DW), crude protein (1.1±0.1 to 1.4±0% DW), crude fat (0.7±0.2 to 1.7±0.2% DW), crude fibre (1.4±0.2 to 2.0±0.2 DW) and carbohydrates (21.4±0.3 to 28.9±0.4%). The pulp of fruit from Harare Airport (HAR) and Mahusekwa (MH) had dry matter (87±1 to 87.5±0.1% fresh weight), mineral ash (3.1±0.3% DW), crude protein (2.3±0.1 to 2.9±0% DW), crude fat (2.0±0.4 to 2.0±0% DW), crude fibre (5.2±0.2 - 6.0±0.4% DW) and carbohydrates (73.6±0.5 to 75±1%). The energy of fruit from Harare suburbs ranged from 446±2 to 542±11kJ/100g and that for pulp of fruit from Harare Airport and Mahusekwa was 1373±8 to1384±20kJ/100g. Carbohydrates constituted the highest nutrient component of *Parinari curatellifolia* fruit pulp. Pulp containing fruit skin had higher concentrations of nutrients measured than pulp without skins.

Key words: *Parinari curatellifolia*, proximate analysis, fruit pulp, energy

INTRODUCTION

In the developing world, some factors responsible for food shortages are competition for agricultural land with other land users, natural disasters like drought, poor agricultural polices, increasing prices and inadequate supplies of food (Adekunle and Oyerinde, 2004; Debela, 2011).

Inadequate food supplies or production negatively influence food and nutrition security which are key areas for human welfare. Protein and energy deficiency among children and adults are some of the problems noticed in developing countries by the Food and Agricultural Organization (Ladeji *et al*., 1995). To address the problems, polices should be designed to sustainably utilize wild plants as sources of nutrients to improve food and nutrition security. In developing countries, wild plants serve as constituent of diet supplying the body with micronutrients, protein and energy (Debela *et al*., 2011). Some fruits growing in the rainforest ecosystem of South West Nigeria for example *Piperguinensis* and *Artocarpus altilis* had levels of protein above 300 g/kg (dry mass) (Adekunle and Oyerinde, 2004). Wild fruits are potential sources of minerals, vitamins, sugars, cellulose and starch (Adepoju, 2009). During droughty periods, when most staple foods are inadequate, people turn to forests in search of underexploited fruits like *Parinari curatellifolia* for provision of nutrients. (Effiong *et al*., 2009; Saka and Msonthi, 1994).

Parinari curatellifolia is an evergreen tree that grows in deciduous woodland, especially Brachystegia woodland (FAO, 1983). The tree has a rounded crown and grows up to 15 to 20m high (ICRAF, 2010). *Parinari curatellifolia* bears oval shaped fruit that are 3 to 5 cm long and 2.5 to 4 cm in diameter (FAO, 1982). The fruits are greenish with grey spots when mature, becoming yellowish when ripe and dark brown when dry. The ripe fruit contains an edible yellow pulp and a woody seed stone that house a kernel.

Parinari curatellifolia fruit is underutilized in Zimbabwe and it was used as food by rural communities during the 2008 period when the country was hit by food shortages and drought (Mutasa, 2010). Determination of the nutritional value of pulp from the fruits gathered from Zimbabwe will help consumers to make it a regular source of food. In this study we report the results of the determination of dry matter, mineral ash, crude fat, crude protein, crude fibre, carbohydrates and energy in oven dried and freeze dried *Parinari curatellifolia* fruit pulp samples.

MATERIALS AND METHODS

Sample collection: The fruit were collected from Greendale (GR), Cranborne (CR), Prospect (PR) and Harare Airport (HAR) in Harare and Mahusekwa (MH) a rural area that is located about 40 km South East of Harare. Polyethene bags with holes that allowed circulation of air were used for handling the collected fruit. Pulp removed from the fruit from GR, CR and PR was stored in a deep freezer at -20°C. Samples were thawed at room temperature in preparation for analysis. The pulp of fruit from HAR and MH was freeze dried and placed in plastic bags which were enclosed in polyethene containers that were stored at room temperature.

Corresponding Author: C. Benhura, Institute of Food, Nutrition and Family Sciences, University of Zimbabwe, Harare, Zimbabwe

Sample preparation: The freeze dried and oven dried *Parinari curatellifolia* fruit pulp samples were brought to room temperature and ground using a mortar and pestle before analysis.

Proximate analysis: The determination of moisture, mineral ash, crude protein, crude fat and crude fibre was done using methods in Association of Official Analytical Chemists (AOAC, 1990). All reagents used were analytical grade reagents.

Determination of dry matter: Three crucibles were dried in an oven at 105°C for three hours, cooled to room temperature in a desiccator and weighed. A sample of 1.5g was accurately weighed into each cooled crucible and placed in an oven set at 105°C overnight followed by cooling in a desiccator and weighing to determine moisture content (AOAC, 1990). The dry matter of the fruit pulp was calculated on a fresh weight basis by expressing dry mass of the pulp as a percentage of fresh weight of the original sample.

Determination of mineral ash: Three clean crucibles were placed in a muffle furnace at 600°C for an hour. The crucibles were transferred to a desiccator, cooled to room temperature and weighed. Samples of 1.5 g each were accurately weighed into the cooled crucibles which were transferred to a muffle furnace set at 600°C and left to ash for 6 hrs. The crucibles were transferred to a desiccator, cooled to room temperature and weighed. The mineral ash content of the pulp was calculated on a dry weight basis by expressing mass of the ash as a percentage of the dry mass of the original sample.

Determination of crude protein: Fruit pulp (1.5 g) was transferred to an 800 ml Kjeldahl flask (AOAC, 1990). The sample was digested in sulphuric acid and distilled in basic medium in the presence of zinc granules to produce ammonia that was trapped in boric acid. The ammonia was titrated with 0.1 M hydrochloric acid and a factor of 6.25 was used to calculate protein from the nitrogen content (Rhee, 2001; Jagat and Basanta, 2007).

Determination of crude fat: Fruit pulp (1.5 g) was accurately weighed into a clean extraction thimble and placed in a soxhlet extractor unit (AOAC, 1990). Fat was extracted for 6 hrs using petroleum ether which was recovered by distillation. After evaporating off the solvent, the flask was dried in the oven at 105°C, cooled in a desiccator and weighed in order to determine the amount of lipid. The crude fat was calculated as a percentage of the dry mass of the pulp used.

Determination of crude fibre: Defatted fruit pulp weighing 1.5 g was digested in 1.25% sulphuric acid, filtered and washed with hot water. The digestion was repeated in 1.25% sodium hydroxide and sample filtered on a sintered glass filter which was then oven dried and placed in a muffle furnace at 600°C to ash the sample (Jagat and Basanta, 2007). The filter was cooled in a desiccator and weighed. Crude fibre content was expressed as percent weight loss on ignition at the ashing temperature.

Determination of available carbohydrates and energy: Available carbohydrate was calculated by subtracting the sum of crude protein, crude lipid, crude fibre and ash from 100% of dry weight sample (AOAC, 1990; James, 1999). The energy value of the fruit pulp was calculated as follows:

Energy value of food (in KJ per 100 g) = [(% available carbohydrates x 17) + (% protein x 17) + (% fat x 37)] (James, 1999)

Statistical analysis of data: Statistical analysis of data was done using Graph Pad Prism 4 software package. The significance of difference among parameters measured was determined using one way Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Dry matter of fruit pulp: Fruit pulp from CR, GR and PR had dry matter ranging from 27 to 34.5%. The means of dry matter for samples from the three sites were significantly different ($p<0.05$). The levels of dry matter measured were in agreement with those measured by other workers (Saka and Msonthi, 1994). Dry matter contents of freeze dried pulp from Harare Airport and Mahusekwa were much higher than those for oven dried pulp from CR, GR and PR. The differences may be attributed to the freeze dried pulp that was not separated from the skins. The levels of dry matter obtained for fruit pulp from HAR and MH were comparable possibly because the fruit trees grow in areas with the same climate and soils.

Mineral ash content of pulp: The ash for samples from CR, GR and PR were comparable ($p>0.05$). Ash content of the pulp samples from the same points were lower than those measured by other investigators (Izhaki *et al.*, 2002; Saka and Msonthi, 1994). Fruit pulp for samples from Mahusekwa and Harare had higher levels of ash compared with those from CR, GR and PR possibly because the pulp for samples from Harare and Mahusekwa was not separated from skins. A product containing pulp and skin may be a better source of minerals than the pulp alone. Pulp for samples from HAR and MH had the same levels of mineral ash. The possible cause of similarity is that the growing conditions of the trees may be similar.

Table 1: Means of triplicate data for pulp of *Parinari curatellifolia* fruit collected from Cranborne (CR), Greendale (GR) and Prospect (PR) in November-December 2009

Parameter	Sample CR	GR	PR
Dry matter (%)*	27.0±0.0	32.9±0.2	34.5±0.4
Mineral ash (%)	1.3±0.1	1.1±0.0	1.5±0.2
Crude protein (%)*	1.1±0.1	1.3±0.0	1.4±0.0
Crude fat (%)*	1.7±0.2	1.4±0.4	0.7±0.2
Crude fibre (%)*	1.4±0.2	1.8±0.1	2.0±0.2
Available Carbohydrates %*	21.4±0.3	27.5±0.5	28.9±0.4
Energy (kJ/100 g)*	446.0±2.0	539.0±10	542.0±11

Measurements are expressed as x±σ where x is the measured result and σ is the standard deviation. Dry matter levels were reported on a fresh weight basis. Mineral ash, crude protein, crude fat and crude fibre were reported on a dry weight basis. For all measurements marked by an asterisk*, means values were significantly different ($p<0.05$). The means for mineral ash data were comparable ($p>0.05$)

Table 2: Means of triplicate data for freeze dried pulp of *Parinari curatellifolia* fruit collected from Harare Airport (HAR) and Mahusekwa (MH) in November 2010

Parameter	Sample HAR	MH
Dry matter (%)	87.0±1.0	87.5±0.1
Mineral ash (%)	3.1±0.3	3.1±0.3
Crude protein (%)	2.3±0.1	2.9±0.0
Crude fat (%)	2.0±0.4	2.0±0.0
Crude fibre (%)	5.2±0.2	6.0±0.4
Available carbohydrates (%)	75.0±1.0	73.6±0.5
Energy (kJ/100 g)	1373.0±8	1384.0±20

Measurements are expressed as x±σ where x is the measured result and σ is the standard deviation. Dry matter levels were reported on a fresh weight basis. Mineral ash, crude protein, crude fat and crude fibre were reported on a dry weight basis

Crude protein: As shown on Table 1, the crude protein of the fruit ranged from 1.1 to 1.4%. The levels obtained were lower than those measured in other fruits for example *Strychnos spinosa, Vitex doniana* and *Ziziphus mauritiana* where the protein levels are higher than 2% (Junk and Robert, 2008; Saka and Msonthi, 1994). Mean protein levels for fruit pulp from CR, GR and PR were significantly different ($p<0.05$). The crude protein for pulp of fruit from Harare and Mahusekwa ranged from 2.3 to 2.9% and were similar to levels determined in fruits from Malawi namely, *Parinari curatellifolia*, *Adansonia digitata* and *Vitex doniana* (Saka and Msonthi, 1994). The differences of protein levels for samples CR, GR and GR from those for MH and HAR were possibly arising from skins which were not separated from the pulp. The skins contributed additional protein to the pulp. Products made from a mixture of pulp and skin may be a better source of protein than one made from pulp alone. The Recommended Dietary Allowance (RDA) for children, adult males, adult females, pregnant women and lactating mothers are 28, 63, 50, 60 and 65 g of protein (Itodo *et al*., 2011). The high protein requirements by humans indicate that *Parinari curatellifolia* fruit is likely to be a poor source of proteins for consumers.

Crude fat: Levels of fat for sample CR and GR were nearer to previously measured value of 1.5% (Adepoju, 2009; Saka and Msonthi, 1994). The fat content of *Parinari curatellifolia* fruit pulp from Table 1 was lower than that measured in other fruits for example *Spondiasmombin* (Adepoju, 2009). There were significant differences among the means of crude fat content for fruit pulp from CR, GR and PR ($p<0.05$). Pulp of fruit from HAR and MH had higher fat content than GR, CR and PR probably due to skins in pulp from HAR and MH contributing additional fat. The pulp from HAR and MH had the same fat content probably because the trees may be growing under similar conditions.

Crude fibre: Means of crude fibre for fruit pulp from CR, GR and PR were significantly different ($p<0.05$). The crude fibre measured in the pulp from CR, GR and PR was lower than that for HR and MH. Fibre levels in samples HR and MH ranged from 5.2 to 6.0% and compare well with a previously measured value of 5.5% (Debela *et al*., 2011; Saka and Msonthi, 1994). The higher fibre in samples HR and MH may be caused by skins which were not separated from the pulp. The skins contribute to the crude fibre content of the mixture. Food products made from a mixture of pulp and skins are expected to have higher fibre content than those made from pulp only. Dietary fibre has been reported to reduce blood cholesterol level, risk of cardiovascular disease and cancer (Itodo *et al*., 2011; Rosamond, 2002). Dietary guidelines from the American Heart Association, though not recommending a specific amount of dietary fiber, state that the consumption of the amounts and types of foods in their recommendations should translate to levels above 25 g of fiber per day (Rosamond, 2002). The recommended Daily Allowance (RDA) for fibre is 18 to 35 g (Itodo *et al*., 2011) implying that 100 g of *Parinari curatellifolia* fruit is inadequate to meet the daily fibre requirements of the body.

Available carbohydrates: Samples from HR and MH contained higher levels of available carbohydrates compared with those from CR, GR and PR. Mean levels of carbohydrates for fruit pulp from CR, GR and PR were significantly different ($p<0.05$). The carbohydrate content in pulp from HR and MR were comparable to values obtained in other fruits (Debela *et al*., 2011). The possible cause of high carbohydrate in pulp from HR and MH is the skins which were not separated from the pulp. Skins contributed to the available carbohydrates in the mixture. The results from Table 1 and 2 show that *Parinari curatellifolia* pulp's major nutrients are carbohydrates which are sources of energy for consumers.

Energy value: Energy values measured for samples from HAR and MH were well above the ones for samples from CR, GR and PR, illustrating that pulp containing skins had a higher calorific value than pure pulp. The energy values for pulp from sites CR, GR and PR were significantly different ($p<0.05$). The energy levels obtained for samples from HAR and MH ranged from 1373 to 1384 kJ/100 g and were comparable to values measured by other workers (Saka and Msonthi, 1994; Effiong *et al*., 2009). A food product made from a mixture of pulp and fruit skin is a better source of energy than one made from pulp without skin.The energy yield of the fruit indicates that the fruit pulp partly contributes to an adult's energy requirement which is pegged at 10 201 kJ/day (FAO, 2008). To meet the daily energy needs, consumers should eat other high energy foods in addition to *Parinari curatellifolia* fruit.

Conclusion: Available carbohydrates constitute the largest nutrient portion of *Parinari curatellifolia* fruit pulp. Oven dried pulp contains around 26% carbohydrates while freeze dried pulp had about 74% carbohydrates. Results of the study showed that *Parinari curatellifolia* fruit pulp is a potential raw material for production of high energy foods. Mineral ash, protein, fat and fibre form a minor component of nutrients in the fruit pulp. Pulp containing fruit skin had higher levels of all nutrients measured than pulp without skin. From the determinations, products made from pulp containing skins will be expected to have higher levels of ash, protein, fat, fibre and carbohydrates than pulp without skins.

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