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# Chemical Compositions of Leaf Protein Concentrate and Bagasse of Pride of Barbados (*Caesalpinia pulcherrima*) Leaves obtained from three Different Locations in Benin City, Nigeria

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**ABSTRACT:** To optimize food and feed production in Nigeria and meet protein demands, viable options need to be explored. Therefore, this study aimed to determine the chemical composition of Pride of Barbados leaf protein concentrate and bagasse. Freshly harvested Pride of Barbados leaves were obtained from three different locations in Benin City and processed for its leaf protein concentrate and bagasse using heat coagulated method. Pride of Barbados leaf protein concentrate and bagasse were analysed for proximate and mineral compositions using standard analytical procedures. Proximate analysis revealed that the dry matter, crude protein, ether extract, crude fibre, ash, and nitrogen free extract contents of Pride of Barbados leaf protein concentrates were 91.17%, 31.12%, 8.33%, 7.92%, 8.2%, and 35.3%, respectively. Pride of Barbados bagasse had a lower crude protein (9.22%) but higher fibre content (10.72%) compared to those of Pride of Barbados leaf protein concentrate. Na, K, Ca, and Mg were the most abundant minerals in Pride of Barbados leaf protein concentrate and bagasse. Chromium was very low in the leaf protein concentrate and bagasse. Proximate compositions were significantly ($p<0.05$) affected by location. Pride of Barbados leaf protein concentrate and bagasse can be used as livestock feed ingredient.

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**Keyword:** Pride of Barbados, Leaf Protein Concentrate, Bagasse, *Caesalpinia pulcherrima*

One of the current trends among nutritionists is finding diverse alternatives that could partially or totally replace conventional food and feeding stuff in human and livestock diets. Apart from the fact that feed items account for up to 75% of total cost of production of stock, the protein fraction of the major (basal) ingredients is one of the highest contributory factors to the rising animal feed cost in Nigeria (Nwokoro, 2015). With the increasing human population in the developing countries of the world, there is competition between man and livestock, as well as industries for available feed ingredients. To optimize food production and meet protein requirement in Nigeria, viable options need to be explored and evaluated (Jiya *et al.*, 2013). Pride of Barbados is a tropical evergreen shrub and belongs to the Fabacae bean family. Its other common names are dwarf Poinciana and Bird of paradise (Russel *et al.*, 1997). It is a leguminous plant that belongs to the leguminosae family, which is the second largest family among the dicotyledonous plant (Prohp *et al.*, 2006). Leafy crops such as grasses and legumes can produce high protein yields in humid climate in a sustainable way when compared with many traditional seed protein crops (Anders, 2021). Therefore, there is need to explore and utilize non-conventional feed sources that have the capacity to yield the same output as conventional feeds, probably at cheaper rate. Leaf protein concentrates have been proving to be a viable alternative protein source. Its crude protein value ranges between 20 and 50% (Olomu, 2011; Aletor and Adebayo, 2012; Sodamade *et al.*, 2013; Akaeze, 2015). Method of processing leaf protein concentrate can be adopted locally and the leaf fractionation process can enhance crude protein and gross energy by 34.8% and 22%, respectively (Agbede *et al.*, 2008). Leaf bagasse, which is a major by-product of the leaf protein concentrate production, can be utilized in livestock diet, particularly in ruminant

and pseudo-ruminant animals, probably because of their relatively high fibre and minerals contents. The objective of this study was to determine the proximate and some mineral compositions of the leaf protein concentration and bagasse of Pride of Barbados (*Caesalpinia pulcherrima*) obtained from three different locations in Benin City, Edo State, Nigeria

## MATERIALS AND METHODS

*Experimental Site:* This research was carried out at the University of Benin, Ugbowo Campus, Benin City, Nigeria, which is located between latitude $6^0$ 20'22.37" N of the equator and longitude $5^0$36'31.02" E of the Greenwich Meridian (Google earth, 2022), in the humid rain forest zone of Southern Nigeria.

*Leaf Protein Concentrate (LPC) Production***:** Leaves of Pride of Barbados *(Caesalpinia pulcherrima)* were harvested fresh from three different locations: Egor (A), University of Benin (B), and Ekosodin (C), in Benin City, Edo State, Nigeria. The Pride of Barbados leaf protein concentrate was produced using heat coagulation method (Pirie, 1987; Olomu and Nwokoro 2009; Sayyed, 2011 and Nwokoro, 2015). The freshly harvested leaves were weighed and washed prior to blending (pulping) with a blending machine. The Pride of Barbados leaf slurry was sieved and pressed to separate the Pride of Barbados bagasse from the juice. The Pride of Barbados leave juice was heated to form protein coagulum at the top. Thereafter, the protein curd was filtered and pressed to separate the Pride of Barbados whey from the curd. The Pride of Barbados leaf bagasse and protein curd were sun-dried and milled. The leaf protein concentrate of the Pride of Barbados was green in colour, while that of the bagasse was pale green. They were kept in air-tight containers prior to chemical analysis.

*Chemical Analysis:* The proximate composition (dry matter, crude protein, ether extract, crude fibre, ash, and nitrogen free extract) of Pride of Barbados leaf, Pride of Barbados leaf protein concentrate, and Pride of Barbados bagasse were determined following the method described by AOAC (2010).

The minerals of the Pride of Barbados leaf protein concentrate and bagasse were analysed after first dry-ashing at 550$^o$C in a Muffle furnance and dissolved in de-ionised water to standard volume. Sodium and Potassium were determined by flame photometry method and phosphorus by vanadomolybdate method of AOAC (2010). Magnesium, calcium, zinc, manganese, iron, copper, and chromium were determined using an atomic absorbtion spectrophotometer.

*Data Analysis:* All data used were means of triplicate (n=3) determinations and were subjected to analysis of variance at 95% level of significance using the Genstat (2005) statistical package (12th edition). Significant means were separated using Duncan Multiple Range Test of the same statistical package.

## RESULTS AND DISCUSSION

The value of the proximate composition recorded for Pride of Barbados leaf protein concentrate (Table 1) ranged from 90.73 – 91.97% dry matter; 28.97 - 22.98% crude protein; 7.89 - 8.73% ether extract; 7.37 – 8.53% crude fibre; 7.74 – 8.47% ash, and 33.73 – 38.19% nitrogen free extract. The Pride of Barbados bagasse contained dry matter (84.30 – 87.03%), crude protein (8.46 – 10.26%), ether extract (19.76 – 20.16%), crude fibre (10.20 – 11.50%), ash (12.22 and 114.18%), and nitrogen free extract (30.63 – 35.36) as shown in Table 2. Except the dry matter and ash content of the Pride of Barbados leaf protein concentrate, other proximate compositions were significantly ($p<0.05$) affected by location. Locations A and C had higher crude protein ($p<0.05$) than location B. Location B recorded the lowest crude fibre and was significantly ($p<0.05$) different from location A and C. Pride of Barbados leaf protein concentrate had a higher crude protein (31.12%) than Pride of Barbados leaf bagasse (9.22%). The crude protein value recorded for Pride of Barbados leaf protein concentrate was slightly lower than the 39.30% crude protein for Moringa leaf protein concentrate (Sodamade *et al.,* 2013); 35.2% crude protein for Amaranthus leaf protein concentrate and 41.7% crude protein for cassava leaf protein concentrate (Aletor and Adebayo 2012); and 32.64% crude protein for rubber leaf protein concentrate (Akaeze *et al.,* 2015). The Pride of Barbados leaf bagasse was higher in crude fibre (10.79%) than the Pride of Barbados leaf protein concentrate (7.92%). Fibre in a diet helps in the cleansing of the digestive tract by removing potential harmful substances from the body system and hence prevents the absorption of excess cholesterol. Fibre also adds bulk to feed and reduces the intake of excess starchy food and feed. The high fibre content of the Pride of Barbados bagasse makes it a potential livestock feed ingredient, particularly for ruminant and pseudo ruminant animals. The ash content of Pride of Barbados leaf protein concentrate and bagasse were 8.2% and 13.15%, respectively. Ash present in food explains largely the amount of minerals found in food or feed substance. The value was higher than those reported for Amaranthus leaf protein concentrate (5.60%) (Aletor and Adebayo 2012) and other vegetable species such as *Talium triangulare* (0.62%). *Rosselle* (0.46%), *Cochorus Olitorius* (0.32%), *Telfaira Oceidentalis* (0.68%), and

*Amaranthus hybridus* (0.41%) (Saidu and Adunbarin 1998). The ash content of Pride of Barbados leaf protein concentrates and bagasse indicates that they are good source of mineral element. However, the ash value were lower than that of the leaf protein concentrate of Rubber (8.64%) reported by Akaeze *et al.* (2015).

**Table 1:** Proximate composition (%) of Pride of Barbados (*Caesalpinia pulcherrima)* leaf protein concentrates obtained from three different locations

| Proximate composition (%) | Locations A | B | C | SEM± |
|---|---|---|---|---|
| Dry matter | 91.57 | 90.80 | 90.73 | 0.29 |
| Crude protein | 31.97[b] | 28.97[a] | 32.43[b] | 0.46 |
| Ether extract | 8.73[c] | 7.89[a] | 8.37[b] | 0.10 |
| Crude fibre | 8.53[c] | 7.37[a] | 7.87[b] | 0.14 |
| Ash | 8.47 | 8.40 | 7.74 | 0.41 |
| Nitrogen free extract | 33.73[a] | 38.19[b] | 33.99[a] | 0.51 |

*[a,b] Means on the same row with different superscripts were significantly different (p<0.05); SEM: Standard Error of Mean*

**Table 2:** Proximate composition (%) of Pride of Barbados (*Caesalpinia pulcherrima)* leaf bagasse obtained from three different locations

| Proximate composition (%) | Locations A | B | C | SEM± |
|---|---|---|---|---|
| Dry matter | 85.69[b] | 87.03[c] | 84.30[a] | 0.07 |
| Crude protein | 8.46[a] | 8.95[b] | 10.26[c] | 0.03 |
| Ether extract | 19.76[a] | 20.04[b] | 20.16[c] | 0.03 |
| Crude fibre | 11.50[c] | 10.46[b] | 10.20[a] | 0.01 |
| Ash | 14.18[c] | 12.22[a] | 13.05[b] | 0.06 |
| Nitrogen free extract | 31.73[a] | 35.36[c] | 30.63[a] | 0.19 |

*[a,b] Means on the same row with different superscripts were significantly different (p<0.05); SEM: Standard Error of Mean*

The mineral compositions of Pride of Barbados leaf protein concentrate and bagasse are presented in Tables 3 and 4. Result revealed that Location did not have any significant effect on mineral compositions Pride of Barbados leaf protein concentrate and bagasse (P>0.05). Of the minerals presented in Table 5, Ca and Mg were the most abundant in the Pride of Barbados leaf protein concentrate and bagasse, while Cr, Cu, Mn, and Zn were the least abundant. The potassium content in the bagasse was higher than that in the leaf protein concentrate. Potassium contents of 138.7mg/100$g$ and 854.67mg/100g were obtained for Pride of Barbados leaf protein concentrates and bagasse, respectively. High amount of potassium in the body was reported to increase iron utilization (Adeyeye 2002) and is beneficial to people taking dulretics to control hypertension (Arinathan *et al*., 2003). The potassium value obtained in this study is higher than 23.20 mg/100g reported for *Moringa oleifera* leaf protein concentrate (Sodamade *et al.,* 2013) and 14.55$mg$/100$g$ reported for astragalina leaves (Gafar *et al.,* 2011). Sodium concentration in Pride of Barbados leaf protein concentrate was 178$mg$/100g.

**Table 3:** Mineral composition (mg/100 g) of Pride of Barbados (*Caesalpinia pulcherrima)* leaf protein concentrate obtained from three different locations

| Mineral compositions (mg/100 g) | Locations A | B | C | SEM± |
|---|---|---|---|---|
| Sodium | 210.30 | 180.41 | 144.30 | 19.08 |
| Potassium | 143.30 | 131.80 | 141.00 | 3.51 |
| Calcium | 860.40 | 831.00 | 760.30 | 29.7 |
| Magnesium | 514.01 | 611.30 | 538.30 | 29.2 |
| Phophorus | 31.51 | 28.01 | 21.43 | 2.95 |
| Iron | 9.32 | 7.11 | 10.14 | 0.91 |
| Zinc | 1.43 | 1.38 | 1.222 | 0.06 |
| Copper | 0.84 | 0.92 | 0.71 | 0.06 |
| Manganese | 2.10 | 1.18 | 2.12 | 0.31 |
| Chromium | 0.051 | 0.053 | 0.048 | 0.00 |

*SEM: Standard Error of Mean*

**Table 4:** Mineral composition (mg/100 g) of Pride of Barbados (*Caesalpinia pulcherrima)* leaf bagasse obtained from three different locations

| Mineral composition (mg/100 g) | Locations A | B | C | SEM± |
|---|---|---|---|---|
| Sodium | 150.80 | 135.21 | 122.10 | 8.30 |
| Potassium | 835.00 | 819.00 | 910.00 | 2.81 |
| Calcium | 645.46 | 822.02 | 773.30 | 52.65 |
| Magnesium | 544.04 | 534.36 | 513.39 | 9.05 |
| Phophorus | 20.21 | 21.41 | 19.90 | 0.46 |
| Iron | 10.47 | 11.01 | 12.04 | 0.46 |
| Zinc | 1.61 | 1.82 | 1.51 | 0.09 |
| Copper | 1.77 | 1.74 | 2.04 | 0.10 |
| Manganese | 1.06 | 0.92 | 0.89 | 0.05 |
| Chromium | 0.049 | 0.078 | 0.046 | 0.01 |

*SEM: Standard Error of Mean*

**Table 5:** Average of the chemical compositions (mg/100 g) of Pride of Barbados (*Caesalpinia pulcherrima)* leaf protein concentrate and bagasse obtained from three different locations

| **Parameters** | **Leaf Protein Concentrate** | **Leaf Bagasse** |
|---|---|---|
| **Proximate composition (%)** | | |
| Dry matter | 91.17 | 85.67 |
| Crude protein | 31.12 | 9.22 |
| Ether extract | 8.33 | 19.99 |
| Crude fibre | 7.92 | 10.72 |
| Ash | 8.20 | 13.15 |
| Nitrogen free extract | 35.30 | 32.57 |
| **Mineral composition (mg/100g)** | | |
| Sodium | 178.34 | 136.04 |
| Potassium | 138.70 | 854.67 |
| Calcium | 817.23 | 746.93 |
| Magnesium | 554.54 | 530.6 |
| Phophorus | 26.98 | 20.51 |
| Iron | 8.85 | 11.17 |
| Zinc | 1.34 | 1.64 |
| Copper | 0.82 | 1.85 |
| Manganese | 1.80 | 0.96 |
| Chromium | 0.05 | 0.06 |

Sodium is an important source of electrolytes within the body. Calcium and phosphorous containing substances are required by animals and humans for bones and teeth development. The value of calcium

obtained in this study was 817.23mg/100g and phosphorus was 26.98.mg/100g. The concentration of magnesium was 554.54mg/100g and is higher than the reported value for *Solanum microcapon* and *Cnidoscolous acinitopholis* leaf protein concentrates, which were $88.60mg/100g$ and $98.30mg/100g$, respectively (Faboya, 1983). The low level of the heavy metal chromium in the Pride of Barbados leaf protein concentrate (0.05mg/100g) and Pride of Barbados leaf bagasse (0.06mg/100g) suggests that it can be safely utilized by animals.

*Conclusion:* Crude protein and crude fibre of Pride of Barbados leaf protein concentrate and bagasse were influenced by Location. However, Location did not have effect on their mineral compositions. Given the relatively high nutrient contents of Pride of Barbados leaf protein concentrates, it is suggested that it has the potential of being used as protein supplement in animal feeding. The bagasse of the Pride of Barbados can be used in ruminant and pseudo-ruminant feeding because of its high fibre content. Therefore, research should be carried out on their utilization by livestock.

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