Nutritional value of runner bean (*Phaseolus cocccinus* L.) grown in Chad

ABSTRACT

In order to evaluate the nutritional characteristics of an ornamental plant called *Phaseolus cocccinus* L., some samples were collected in order to evaluate the nutritional value such as proteins, lipids, some minerals and vitamins. The physico-chemical analyzes carried out used standard methods. The results show that the carbohydrate and lipid contents are very low, they are respectively 1.76% and 2.4%. The protein content is almost similar to common bean (23.34%). The energy value is 110kcal/100g and the dietary fiber content is 9.3g/100g of DM, much lower than the recommended nutritional intake. The protein content is almost similar to common bean (23.34%). The energy value is 110kcal/100g and the dietary fiber content is 9.3g/100g of DM, much lower than the recommended nutritional intake. The highest mineral content is potassium (880.03g/100g DM) and the lowest content is sulfur (0.17mg/100g DM). The iron content is 43.66mg/100g of DM The contents of β-carotenes and vitamin C are low, they are respectively 3% and 9.3%. The consumption and popularization of *Phaseolus cocccinus* L. among populations could be envisaged to ensure availability throughout the year to ensure food security and thus contribute to the fight against malnutrition.

Keywords: runner bean, nutritional value.

1. INTRODUCTION

The common bean is one of the most consumed legumes in the world. This plant plays an important role in human nutrition. It is the source of starch (starch) and protein, micronutrients including iron and zinc, and fiber for more than 300 million people in the tropics [22]. The term bean, in Latin *Phaseolus,* is a genus of plants of the Fabaceae family which groups the species of bean in the strict sense, that is to say about eighty species of annual herbaceous plants native to Central America, four of which are of real interest economic and agricultural. The best known is the common bean *Phaseolus vulgaris* which is a plant native to Central and South America. The word "bean" refers to both the fruit, the seed and the plant itself. Around 7,000 years ago, beans were cultivated by Indian tribes in Peru. Gradually, the plant spread across America, over the migrations of the Indians, so that

thereafter, the Spanish explorers of the 16th century found this plant throughout Latin America. Beans spread to Africa, Asia and Europe in the early 17th century, thanks to Spanish and Portuguese explorers. Currently, there are more than 100 varieties, whose characteristics vary according to shape, color, flavor and nutritional value [21]. Pulses are the main sources of protein for most people in Africa, Asia, Latin America and the Near East. There is every reason to believe that the importance of legumes in the diet is growing given its importance for health [14]. Runner bean is a scarlet legume or Bean-flower (*Phaseolus coccineus* L.), is a perennial herbaceous plant of the Fabaceae family, appreciated for its scarlet red or white flowers in bouquets blooming in summer or, for certain varieties, as a vegetable for their edible seeds [19]. Many cultures regard legumes as the protein of the poor. They are underestimated for many reasons: they can cause bloating and flatulence. Their cooking time is too long if they are not soaked enough in water. They contain so-called anti-nutrient substances that affect the human body's ability to absorb proteins, amino acids, minerals [28]. Scarlet runner bean is widely grown in many countries as an ornamental plant for its climbing habit and colorful flowering, and many people who grow them do not suspect that it is an edible plant. The young pods of some varieties are edible as green beans but they tend to become stringy quickly. The white colored seeds are edible and can be eaten as dried beans [19]. The colored varieties contain toxic substances, such as trypsin inhibitors and must therefore be cooked before consumption. The tuberous roots, rich in starch, are still eaten by some Native Americans of Central America. However, they are likely to contain toxic substances [20]. Runner bean *Phaseolus coccineus* L. is a staple food in the Middle East and Mediterranean regions, rich in complex carbohydrates, and protein, Runner bean *Phaseolus coccineus* L. is an interesting food to include in the meals of individuals following a frugivorous and vegan diet, but also of individuals who are trying to eat healthier.

In Chad, it is not consumed because it has not entered into dietary habits. It would therefore be important to highlight the nutritional values of this plant in order to encourage its consumption in the Chadian population.

2. MATERIALS AND METHODS

The study environment and pre-treatment: the samples are taken from April 2020 to April 2021 in the gardens of the city of N'Djamena. The dry pods Variety “Emergo” large white grains are harvested, the seeds are removed from the pods and pounded in a wood mortar. The flours are sieved in an Analysensieb sieve. AFNOR-ASIMW: 500; Nr: 152014. Rahmen Edelsdahl. The dry matter, fibers,

proteins were determined at the Foodstuffs Quality and Control Study Center (CEQOCDA) in N'Djamena, Chad. Total sugars, lipids, β-carotenes, lycopenes) were determined at the Laboratory of the Center for Biological Sciences, Food and Nutritional (CRSBAN) and all minerals were determined at the analysis laboratory of the National Soil Office (BUNASOLS) of Burkina Faso. Determination of the water, ash, protein and lipid content The different contents are determined as follows: water (in an oven maintained at 105°C for 3 hours until a constant weight is obtained), ashes (muffle furnace), proteins (Kjeldahl) and lipids (soxhlet) [1], [2].

2.1 Determination of total sugar content, energy value and vitamin C

The dosage of total sugars was done by the spectrophotometric method of the samples [5], the determination of the available energy value was by the method of Merril and Watt [17]. The dosage of vitamin C was made by the method of Massot based on the discoloration (reduction) of 2,6-dichlorophenolindophenol [16].

2.2 Determination of calcium, copper, iron, magnesium, manganese and zinc content

These minerals are contained in the ash obtained. These contents were determined from Atomic Absorption Spectroscopy [24]. The Spectroscope is a PELKINE lmer model 3110 device (Connecticut, USA). An Al-Ca-Cu-Fe-Mg-Si-Zn cathode lamp was used.

2.3 Determination of phosphorus, potassium, sodium and sulfur

Phosphorus (P), potassium (K) and sodium (Na) were determined using the Corning 430 flame photometer [29]. The determination of sulfur was done by the method of Chaudry et al. [10].

2.4 Determination of β-Carotene and lycopene

β-Carotene, total Chlorophyll and lycopene contents were determined according to the method described by sombie et al. [23]. β-carotene and lycopene contents were calculated according to the following equations:

Lycopene (mg/100 ml) = $-0.0458\ A_{663} + 0.372\ A_{505} - 0.0806\ A_{453}$.

β-carotene (mg/100 ml) = $0.216\ A_{663} - 0.304\ A_{505} + 0.452\ A_{453}$.

2.5 Statistical analyzes

Means and standard deviations were calculated using Microsoft Office Excel 2007 software.

3. RESULTS AND DISCUSSION

3.1 Dry matter and macronutrient content

The content of dry matter and macronutrients is presented in Table 1. Beans being a legume which has a low sugar content (1.76%), also has a low glycemic index and contributes to good cardiovascular health [8], [26]. The protein content is 23.34% almost similar to white bean (*Phaseolus vulgaris* : 24.5%) in Madagascar [21]. Many grain legumes including the genus *Phaseolus* hold an important place in food because of their high protein content. Common bean varieties have a total protein content between 18.53% and 28.53% [3]. In North America, pulses are classified as a source of protein alongside meat and eggs. In France, the Nutrition Program recommends increasing the consumption of pulses [23]. The lipid content (2.4%) is lower than white Madagascar beans (3.5%). Carbohydrates, proteins and lipids are almost similar in several legumes [23].

3.2 Calculation of the energy value

Energy value: 1.76×4+ 23.34×4+ 2.4×9= 110Kcal/mol.

The energy value which is 110kcal/100g is much lower than the Recommended Energy Intake which is 400kcal/100g [12].

3.3 Contents of vitamin c, beta-carotenes, lycopenes and dietary fibers

The vitamin C, beta-carotene, lycopene and dietary fiber contents are shown in Table 2.). Fibre, minerals and vitamins are highly variable in legumes [23]. The fiber content of Phaseolus coccineus L. is 9.3g/100g of DM much lower than that of Phaseolus lunatus which is 16.8g/100g of DM. This difference would certainly be unlike variety [27].The fiber content much lower than the recommended nutritional intake for adults which is 17.5g/day and adolescents 14.2/day [5]. The fibers facilitate intestinal transit and contribute to good gastrointestinal health [9], [25]. β-carotene is the main carotenoid in carrots and lycopene is the main carotenoid in tomatoes. β-carotene from Phaseolus coccineus L is 30.99 mg/100g much lower than that of the carrot which is 88.4 mg/100g; lycopene is 95.63 mg / 100g much lower than that of tomato which is 127mg / 100g of DM [4]. The vitamin C content is 116.56µg/100mg which is above the Recommended Daily Allowance which is 40mg for adolescents and 45mg for adults [14]. β-carotenes, lycopene and vitamin C are antioxidants necessary for the proper functioning of the body. They improve cell vision, growth and differentiation, embryogenesis,

maintenance of epithelial barriers, immunity and decreases preschool mortality [11] [17], [28]. The conversion of β-carotene into vitamin A takes place in the wall of the intestine. Six (6) mg of β-carotene in food form results in 1 mg of retinol. Therefore, in the absence of consumption of animal products, it is therefore necessary to consume a large quantity of β-carotene to cover vitamin A requirements [16].

3.4 Ash and mineral content

The ash and mineral content is shown in Tables 3 and 4. The highest mineral content is potassium (880.03g/100g DM) and the lowest content is sulfur (0.17mg/100g DM). The work of Randrianiaina [22] on the bean (*Phaseolus vulgaris*) also found a higher potassium content 1154.2 g/100g of DM but the lowest content was found for sodium 9.57 g/100g DM. These different variations can be explained by the difference in varieties. Potassium is needed to regulate cell water balance, carbohydrate utilization and protein building. It works against heart rhythm disturbances and intervenes in the regulation of the osmotic pressure of the cell [12]. Sodium contributes the acid-base balance and the body's water balance. It promotes nerve function and muscle contraction [19].

The iron content is 43.66mg/100g DM and can cover the recommended daily intake of iron which is 27.4mg/100g (men aged 18 and over) but not for women aged 18 and over which is 58.8mg/100g [13]. Iron is an essential nutrient because it helps in the neurological and cognitive development of newborns. Iron is also involved in the formation of hemoglobin, myoglobin and enzymes play a key role in many metabolic reactions [19].

The zinc content is 3.33g/100g DM but does not cover the daily intake Recommended minimum which is 9.8 mg/day (FAO, 2004). Zinc deficiency has a negative impact on the immune system and on growth and is associated with a higher risk of morbidity, in particular diarrhea [8].

Table 1 : Dry matter and macronutrients content

Runner bean	Dry matters (g/100g)	Total sugars	Lipids (g/100g)	Proteins (g/100g)
Mean	98,75	1,76	2,4	23,34
S.deviation	0,74	0,08	2,17	0,16

S.: Standard

Table 2 : Vitamins, lycopenes and diatery fibers content

Runner bean	Vitamin C (µg/100mg)	Beta-carotenes (mg/100g)	Lycopenes (mg/100g)	Diatery fibers (g/100g)
Mean	116,56	30,99	95,27	9,3
S. deviation	2,13	0.02	0,51	0,11

S.: Standard

Table 3 : Ash and mineral content

Runner bean	Ash (g/100mg)	Calcium (mg/100g)	Copper (mg/100g)	Iron (mg/100g)	Magnesium (mg/100g)	Manganese (mg/100g)
Mean	116,56	212,87	0,76	43,66	169,26	0,99
S. deviation	21.3	2,08	0,82	0,55	2,04	00,5

S.: Standard

Table 4 : Minerals content

Runner Bean	Phosphorus (mg/100g)	Potassium (mg/100g)	Sulfur (g/100g)	Sodium (mg/100g)	Zinc (mg/100g)
Mean	316,44	880,03	0,17	9,75	3,33
S. deviation	4,76	1,2	0,01	1,66	0,05

S.: Standard

4. CONCLUSION

The physico-chemical characteristics of *Phaseolus coccineus* L. have shown, like several other legumes, that it is rich in proteins and minerals. but low in carbohydrates. The physico-chemical results could encourage people to gradually integrate it into their diet. Further research should be done to determine other physico-chemical parameters to have a complete nutritional table.

DISCLAIMER

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

REFERENCES

1. AOAC. Official Methods of Analysis (vol 15th ed). Washington, DC: Association of Official Analytical Chemists; Washington DC. 1990; 831-835.
2. AOCS. Official Methods and Recommended Practices (4th edn). American Oil Chemists Society; Washington D.C.; 1990.
3. Andriamamonjy N. "Nutritional value of dry seeds of seven varieties of common bean (Phaseolus vulgaris) and two varieties of ambergris (Vigna umbellatta), thesis of D.E.A in Biochemistry University of Antananarivo, Madagascar; 2000.
4. Antoine ED. Etude de l'impact des procédés de transformation sur la diffusion des caroténoïdes : cas du lycopène de la tomate. 2014. Thèse, Université d'Avignon et des Vaucluse, France. 191 pages.
5. Handles. Individual national food study report; 2009. 225 pages.
6. Azzouzi N, Zantar S, Aghmir N, Britel MR, Maurady A. Changes in Physicochemical Properties of Wild and Cultivated Blackberry during Postharvest Cold Storage. Journal of Food Quality and Hazards Control. 2021; 71-77. DOI: 10.18502/jfqhc.8.2.6471.
7. Baluku S, Assumani L, Obedi N. Sensory, culinary and physico-chemical analyzes of bean varieties grown in the highlands of Uvira-Sud-Kivu RD Congo. Journal of Applied Biosciences. 2018; (124): 12468-12475. ISSN 1997-590.
8. Brown KH, Peerson JM, Rivera J, Allen LH. Effect of supplemental zinc on the growth and serum zinc concentrations of prepubertal children: a meta-analysis of randomized controlled trials. American Journal of Clinical Nutrition. 2002;75(6):1062-71
9. Field M, Anderson JW, Knudsen BKE. Supplement pulses and human health. Brit. J. Nutr., 88. 2002 (S3): 237-319.
10. Chaudry IA, Massoumi A, Cornfield AH. Determination of Sulfur Tissue by Turbidimetry. Plant Anal, Ref, Proc, For S. US/SCSB≠368. 1992: 55-57. ISBN: 1-58161-368-7.
11. Erwan G. Effects of lycopene and -carotene on the physiology of adipose tissue: An overall positive impact on the pathophysiological disorders associated with obesity? 2010 University of the Mediterranean Aix Marseille II. France. : 57 pages.
12. FAO. Improving nutrition through home gardening. A training package for preparing field workers in Africa; 2001. FAO Rome.

13. FAO. Vitamin and mineral requirements in human nutrition. Second Edition; 2004. 361 pages.
14. Fikiri B. Determination of nutrient content and evaluation of culinary and sensory characteristics of 11 local varieties of beans grown in Kabare; 2016. UCB Brief. 54 pages.
15. Hama-Ba M, Siedogo M, Ouedraogo A, Dao HM, Dicko HM and Diawara B. Consumption patterns and nutritional value of food legumes in Burkina Faso. Ajfand. 2017; Vol 17 N0 4. DOI: 10.18697/ajfand.80.17315.
16. Kayalto B. Characterization of processes, nutritional evaluation and enrichment of five (05) infant flours from Chad with vitamins A and C, iron and zinc based on Moringa oleifera Lam. and néré pulp (Parkia biglobosa Jacq. Benth). Thesis in human nutrition and food toxicology; 2016. Ouaga I University, Pr Joseph Ki-zerbo of Ouagadougou. 209 pages.
17. Massot C. Analysis of variations in vitamin C content in tomato fruit and role of light environment. Thesis, University of Avignon and Pays De Vaucluse; 2010. France. 229 pages.
18. Merrill AL and Watt BK. "Energy Value of Foods: Basis and Derivation". Agriculture Handbook, Washington DC, ARS United States Department of Agriculture. 1955; No. 74.
19. Ogbonnaya JA, Ketiku AO, Mojekwu CN, Mojekwu JN and Ogbonnaya JA. "Energy, iron and zinc densities of commonly consumed traditional complementary foods in Nigeria". British Journal of Applied Science and Technology. 2012; (2): 48–57.
20. Polese JM. The cultivation of beans and peas. 2006; 57-57. ISBN 9782844164179.
21. PROTA. Plant resources of tropical Africa. Cereals and Pulses, PROTA. 2006; 155-155.
22. Randrianiaina TMJO. Physico-chemical study and yield of bean cultivation, using lonatany organic fertilizer. Thesis for obtaining a master's degree in chemistry. 2020; 78 pages. University of Antananarivo, Madagascar.
23. Schneider A and Huyghes C. Pulses for sustainable agricultural and food systems; 2015. ISBN: 978-7592-2335-0. 515 pages.
24. Sombié PAED, Sama H, Sidibé H, Kiendrébéogo M. Effect of Organic (Jatropha Cake) and NPK Fertilizers on Improving Biochemical Components and Antioxidant Properties of Five Cowpea (Vigna unguiculata L. Walp.) Genotypes. J Agric Sci. 2019;11(10):48.

25. Soro S, Konan G, N'Guessan D and Koffi E. Formulation of infant foods based on soy-enriched yam flours. Afjand Vol. 2013; 13 No. 5.
26. Taylor C, Buckley J Field M, Patterson CA. 2012. The nutritional value and health benefits of pulses for obesity, diabetes, heart diseases and cancer. Brit. J. Nutr. 2012; 108: S1-S176.
27. Tchumou M, Yapi G and Wohi. 2019. Graines de haricot sec (Phaseolus lunatus) consommées au Sud et Est de la Côte d'Ivoire : Une alternative dans la lutte préventive des maladies cardiovasculaires, le diabète de type 2 et [Dry seeds of (Phaseolus lunatus) consumed in the South-East of Côte d'Ivoire can thus contribute to the prevention of cardiovascular risks and obesity]. International Journal of Scientific & Engineering Research Vol 10, Issue 12, ISSN 2229-5518.
28. Vidailheta M, Rieub D, Feilleta A, Bocquetc JP, Chouraquid. D, Dupontf D, Frelutg C Girardeth ML, Hankardi JP, Rozée R, Siméonid JC, Turckj U, Briendk D. Vitamin A in children - An update from the Nutrition Committee of the French Pediatric Society Vitamin A in Pediatrics: an update from the Nutrition Committee of the French Society of Pediatrics. EDITIONS ELSEVIER MASSON. 29 Pages.
29. Walinga I, Kithome M, Houba VJG et Vander Lee JJ. Spectrophotometric determination of organic carbon in soil; 2008. Pages 1935-1844; https//doi.org/10.1080/00103629209368715.