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COMPARATIVE STUDY OF NUTRITIONAL VALUES OF SPIRULINA (SPIRULINA PLATENSIS NORDTSEDT) FROM THREE FARMS IN BURKINA FASO: CASE OF MACRONUTRIENTS

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ABSTRACT

The job is to compare the nutritional value of spirulina produced at the Center for Research in Biological Sciences Food and Nutritional of Ouagadougou University that the farm of "Nayalgué" and "Ouahigouya". Eighteen (18) Spirulina samples of approximately 150 g each of which six (6) per farm were collected. The physicochemical parameters were determined. This study shows that Spirulina produced on the farm of "Nayalgué" has the best levels of macronutrients with 55.66% protein, 11.66% total sugars and 5.66% fat followed by spirulina produced at the Center for Research in Biological Sciences Food and Nutrition with 54.66% protein, 11.33% of total sugars and 5.33% fat and finally that of the "Ouahigouya" farm with 48.33% protein, 9.66% total sugars and 4.00% fat. The spirulina of the farm of "Nayalgué" presented the best contents in protein, total sugar and fat. The richness of these macronutrients gives it an important nutritional value with remarkable nutritional potentialities.

KEYWORDS: Spirulina, nutrient, "Nayalgué", "Ouahigouya", Burkina-Faso.

INTRODUCTION

Spirulina platensis (Oscillatoriaceae) is a blue-green microalgae that has been found by several scientists and nutritionists to be a functional food with exceptional nutritional qualities.[1] It is promoted by several structures within the United Nations organization and world Health Organization for its use in the fight against acute malnutrition in the world.[2] The blue-green color and the phycocyanin content have earned it the name of blue algae.[3] It is cultivated at large scale in numerous countries for commercial purposes,[4] and are marketed as dietary supplement being considered "nutraceuticals" for their wide use as a rich source of minerals, proteins, antioxidants, polyunsaturated fatty acids, carotenoids, among other.[5,6] Spirulina supplements have been certified as safe and hence can be used as food products.[7] It has been consumed for centuries by some peoples of Africa and America and is a food of high nutritional quality thanks to the diversity and the richness of its constituents which attribute to it nutritional and biological virtues quite remarkable.[1,8] The cultivation of spirulina must be improved and especially that there are differences of the chemical composition related to certain factors like origin, nature of sample, conduct of culture, mode of drying, method of retention. With a view to developing a pilot for the production of active spirulina biomolecules for nutrition of vulnerable people, this study contributes to existing data, information on the chemical compositions of spirulina produced at different wesites, where the comparison on the nutritional value of spirulina produced at three farms (CRBSFN farm, Koudougou "Nayalgué" farm and "Ouahigouya" farm) from Burkina Faso.

MATERIAL AND METHODS

Biological material

The biological material consists of spirulina from three sites which are: the Center for Research in Biological Sciences Food and Nutrition (CRBSFN) of Ouagadougou University; the farm "Nayalgué" of Koudougou and the farm of "Ouahigouya".

Farms producing spirulina

CRBSFN Culture Basin

The production of Spirulina at the Center for Research in Biological Sciences Food and Nutrition (CRBSFN) was carried out under shelter. Two reinforced concrete basins of rectangular shape and rounded corners were built. These basins are in an enclosure covered with a roof in translucent sheets and the sides surrounded by fine wire

mesh. Each basin has 12.5 m^2 of surface, 50 cm deep, and 2750 L of volume. Each basin has been equipped with a paddle wheel and equipped with a timer to ensure discontinuous agitation of the culture medium. The agitation worked for 30 minutes and 15 minutes of rest with a stop at night. The cultivation method is semi-artisanal in view of the small size of the pond.

Seeding

This operation consisted of starting a new culture basin. The input quantities were weighed according to the Jourdan formula using PR 503 Delta Range scale for low quantities (<1000g) and Honest type of 20kg capacity for measurements over 1000 g. [9] These inputs were then dissolved in the water, giving the new culture medium. The seed used to grow the first pond came from the Loumbila production site. The choice of this site is explained by its proximity to Ouagadougou. To ensure the purity of spirulina and check the presence or absence of foreign algae, the seed was first observed under an optical microscope.

Culture center

The new culture medium used is that proposed by Jourdan with however some modifications in relation to the water used for the culture. Control of the parameters of the culture medium such as pH, spirulina concentration of the culture medium (by a Secchi disk), the water level and the temperature took place every morning from 8 hours.

Feeding ponds

After each harvest, inputs were brought to the basins in which the harvest was made and the amount of each input is a function of the amount of dry Spirulina harvested.

Farm "Nayalgué" of Koudougou

The production management of "Nayalgué" farm differs from that of CRBSFN in drying mode and the stirring frequency. The only basin at which samples are harvested is out of shelters and 200 m^2. The mixed solar / gas dryer that can be used during the rainy season is used.

Farm of "Ouahigouya"

The production line on the farm of "Ouahigouya" is the same as at the level of the CRBSFN and the farm of "Nayalgué". Three basins are functional and each basin contains 22 m^3 of culture. The basin in which our samples were taken is out of shelter.

Sampling

The samples consisted of spirulina harvested at CRBSFN, "Nayalgué" farm in Koudougou and "Ouahigouya" farm. Each sample consisted of samples of dry spirulina biomass from several locations of spirulina harvested at the three sites. A total of eighteen (18) samples, of which six (6) per farm were used for analyzes.

The samples of "Nayalgué" and "Ouahigouya" were shaped straw and packaged in aluminized bags and those of CRBSFN in plastic bag and then enclosed in sealed jars boxes away from moisture and light. An aluminum grinder (mortar-pestle) and a mesh screen 0.5 mm in diameter allowed the samples to be powders.

Determination of macronutrient composition

Analyzes of macronutrients (protein content, fat and total sugars) and other parameters such as moisture content and ash content were made in the CRBSFN laboratory at Ouagadougou University. The protein content is determined by the Kjeldahl method.[10]

- The determination of fat content is carried out according to Soxhlet extraction method using hexane as refluxing solvent.[10]
- The determination of the total sugars is carried out using dimethylsulfoxide.
- The moisture content is determined by oven drying at 103 ° C for three hours.[10]
- The incineration is carried out so as to obtain all the cations (excluding ammonium) in the form of carbonates and other anhydrous mineral salts.[10]

Calculation of energy value and statistical analysis

The energy value of Spirulina was determined from the Merrill and Watt coefficients.[11] Either sample whose analysis gives: P% Protein, G% Carbohydrate, and L% Lipid. The energy value of the sample was calculated by the following relationship.

$$P * 4\ Kcal + G * 4\ Kcal + L * 9\ Kcal = X\ Kcal / 100\ g$$

P: protein content; G: carbohydrate content; L: lipid content.

The data was first entered using Excel software and subsequently compared by the SPSS 17.0 software. A paired sample t-test was used.

RESULTS AND DISCUSSION

Nutrient composition

Macronutrient composition

The macronutrient composition of spirulina varies from farm to farm as shown in Table 1.

Table 1: Percentage levels of macronutrients harvested Spirulina (%).

Samples	Protein	Total sugars	Fat
CRBSFN Laboratory	54.66	11.33	5.33
Farm of "Nayalgué"	55.66	11.66	5.66
Farm of "Ouahigouya"	48.33	9.66	4.00

The highest protein content of spirulina is that of "Nayalgué" (55.66%), higher than that CRBSFN (54.66%) and "Ouahigouya" (48.33%). However, the latter is close to 47.87% obtained at Koudougou minor seminary farm.[12] The proportions 55.66% and 54.66%

respectively for the farm of "Nayalgué" and CRBSFN are close to 57.10% and 59.3%.[13,14] It should be noted, however, that our protein results are 61.74%, 64.5%, 65%.70% different.[15,16,17,18,19] Changes in protein content may be due to inputs. In fact, the assimilation of inputs introduced into the culture medium may vary depending on the maintenance of the pond, nutrient availability, temperature and light.[20] The input influencing the protein content is potassium nitrate which is source of nitrogen in culture medium. Spirulina is therefore a great source of protein for vegetarians. Furthermore, this protein is highly absorbable.[21] The growing environment, climate difference, or techniques used to collect Spirulina platensis may also explain differences in protein content from one country to another.[22] So, the content is 65% of proteins in Switzerland; 61.3% in Burkina Faso then 58.61% and 50.24% in Chad.[23,24,25] The results in total sugars were 11.66%; 11.33% and 9.66% respectively at the farm of "Nayalgué", the CRBSFN and the farm of "Ouahigouya". So our results are similar to 12.4%, 13.84% and 11%.[22,13,17] Nevertheless, none of our results are in the range of 13 to 25%, 14 to 24%, 15 to 25% and 24.39%.[26,14,22,27] This variation can be explained by the nature of the inputs and their uses in the culture medium. There is also a variation in fat depending on the farm. The content 5.66% of "Nayalgué" and 5.33% of CRBSFN are close to 6%.[13,28] So 5.66% of the samples of "Nayalgué" is in the range of 5.6 to 7% of the lipid content.[29,30,26] The proportion 4.00% to fat content of "Ouahigouya" is different from 11.5 and 11%.[22,31] This fat content can be significant and reach 30.12%.[27] Differences in fat are likely related to climatic conditions such as temperature, humidity and sample conditioning. Indeed our samples before being analyzed were kept for about two weeks. This can probably justify the low fat content. In other studies, it has also been shown that fat composition decreases over time.[13] With a fat content of less than 6% for our samples, spirulina can be classified as one of the least fatty food supplements. This characteristic gives it the advantage of being preserved fairly easily because the unsaturated fatty acids can oxidize easily with a content of less than 6% fat.

Certain physicochemical parameters have also been sought. This is the water, ash and calorie content as shown in Table 2.

Table 2: Ash content in water and calorie samples from the three farms.

Samples	Moisture (%)	Ash (%)	Energy Value (kcal/100g)
Laboratoire CRBSFN	7.66	9.66	319.66
Ferme "Nayalgué"	8.00	7.66	324.33
Ferme de "Ouahigouya"	7.66	5.00	278.66

The ash content of the CRBSFN samples (9.66%) is higher than that of the "Nayalgué" farm and the "Ouahigouya" farm. This rate is close to 9.41; 10.76% and 10.38%.[15,22,13] The ash content of 9.66% and 7.66% obtained respectively at CRBSFN and t "Nayalgué" farm belong to the range of 7 to 13%.[32] The ash content of Spirulina is a function of the Spirulina strain. This is the case of the ash composition of Spirulina maxima (34%) which is higher than that of Spirulina platensis (7.93%).[33,27] The variations observed could be related to the influence of the composition of the environment and the washing of the biomass of spirulina after the harvest. The washing can often rid spirulina of mineral salts but with a risk of losing part of the biomass. Compared to the water content, the results of the samples from CRBSFN and the farm of "Ouahigouya" are identical (7.66%) and are slightly lower than the samples of the farm of "Nayalgué" (8.00%). Our results are similar to 7.24% but above 6% and 4.87% then in the range of 6 to 8%.[27,13,32] Changes in moisture content could be explained by the way in which biomass is dried. This drying took 5 hours at the "Nayalgué" farm with the solar / gas mixed dryer, 5 hours and 30 minutes at the CRBSFN laboratory with the shell dryer and 6 hours at the "Ouahigouya" farm with the solar mixed dryer / gas. The water content of spirulina is therefore subject to variations because it depends essentially on the efficiency of the drying and often of the conditioning mode.[33] Factors such as temperature, illumination, salinity, amount of oxygen and minerals provide different amounts of natural compounds.[34,35,36,37]

The samples from three farms are on the whole a source of calorie intake which is not negligible compared to the average calorific values which are 278.66 kcal/100 g for the farm of "Ouahigouya", 319.66 kcal / 100 g for CRBSFN and 324.33 kcal / 100 g for the farm of "Nayalgué". These calorific values are less than 397.3 kcal / 100 g, 330 kcal / 100 g,[7] 344 kcal / 100 g et 518,84 kcal.[14,12,37,38,27] The variations can be explained by the protein, fat and total sugar contents which represent the energetic constituents of Spirulina.

A comparison test of macronutrient contents from one farm to another as shown in Table 3 revealed significant differences.

Table 3: Comparison of macronutrients of spirulina from CRBSFN farm, "Nayalgué" and "Ouahigouya".

Pair	Parameter	*P*
1	CRBSFN protein - NYG protein	0,742[a]
2	OHG protein - NYG protein	0,058[a]
3	CRBSFN protein - OHG protein	0,019[b]
4	CRBSFN total sugar - NYG total sugar	0,742[a]
5	OHG total sugar - NYG total sugar	0,074[a]
6	CRBSFN total sugar - OHG total sugar	0,338[a]
7	CRBSFN fat - NYG fat	0,423[a]
8	OHG fat - NYG fat	0,038[b]
9	CRBSFN fat - OHG fat	0,057[a]

NYG : "Nayalgué", OHG : "Ouahigouya"
- The values with the letter a in exponent correspond to values of which p> 0.05;
- The values carrying the letter b in superscript corresponds to the value of which p <0.05;
p: Threshold of service.

It can be seen from Table 3 that a significant difference was observed between the protein contents of the CRBSFN samples and those of "Ouahigouya". This is shown by the value of the significance level p (0.019). It is the same for the fat contents between the samples of "Ouahigouya" and those of "Nayalgué" whose threshold p is 0.038. However no significant difference was observed for the total sugar content between the three farms.

As for macronutrient contents, the test for ash samples, moisture and energy value from one farm to another is shown in Table 4.

Table 4: Comparison of some physicochemical parameters of the spirulines of the CRBSFN farm, "Nayalgué" and "Ouahigouya".

Pair	Parameter	*P*
1	CRBSFN ash - NYG ash	0,074[a]
2	OHG ash -NYG ash	0,015[b]
3	CRBSFN ash- OHG ash	0,005[b]
4	CRBSFN Humidity - NYG Humidity	0,742[a]
5	OHG Humidity - NYG Humidity	0,724[a]
6	CRBSFN energy value-NYG energy value	0,728[a]
7	OHG energy value - NYG energy value	0,046[b]
8	CRBSFN energy value - OHG energy value	0,002[b]

-NYG : "Nayalgué", OHG : " Ouahigouya"
- The values with the letter a in exponent correspond to values of which p> 0.05;
- The values carrying the letter b in exponent correspond to values of which p <0.05;
-p: Threshold of service.

Significant differences were noted on the one hand between the ash content of the samples of the farm of "Ouahigouya" and that of "Nayalgué" (p = 0.015) and then the value calorique des samples from the "Nayalgué" farm and the "Ouahigouya" farm (p = 0.046) and between the samples from this farm and those from CRBSFN (p = 0.002).

CONCLUSION

It emerges from this study that spirulina has remarkable macronutrient potential. So the "Nayalgué" farm of Koudougou presented in majority the best contents in macronutrients. Production management can so be easily popularized, especially since all materials and most equipment as well as inputs are accessible. Spirulina can therefore continue to be considered a quality dietary supplement.

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