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Effects of Planting Locations on the Proximate Compositions of *Moringa Oleifera* leaves

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ABSTRACT: *Moringa oleifera* is cultivated all over the world as it is commonly used as nutritional and medicinal plant. This study was carried out to determine the effect of various locations in Ejigbo and Egbedore Local Government Areas, (LGA) in Osun State and Surulere LGA in Oyo State on the nutritional compositions of *Moringa oleifera* leaves. Fresh leaves of *Moringa oleifera* were harvested from *moringa* trees growing at sixteen different locations in Ejigbo and Egbedore LGAs. The analysis of the study was then based on four principal locations namely Ara tagged S1, Igbon tagged S2, Ejigbo tagged S3 and Oko tagged S4. The leaves were oven dried and their proximate contents were determined using standard analytical techniques. Ash, moisture, crude fat, crude fibre, carbohydrate and protein contents were determined according to conventional method. The results of proximate analysis revealed significant difference between different locations and the ash, moisture, crude fat, crude fibre, carbohydrate contents but there was no significance recorded for crude protein at different locations Moreover, the highest level of crude fat (11.83%); crude fibre (12.42%); ash content (12.4%) and carbohydrate (49.9%) were recorded in Ara. The significant negative and positive associations recorded between the nutritional components and different locations revealed the extents of the influence of soil characteristics on the *moringa* leaves at these locations. Therefore, soil factors should be considered by farmers in the planning the establishment of *moringa* plantation. © JASEM
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Keywords: locations, *moringa*, LGA, proximate composition, soil factors

Moringa leaves contain more vitamin A than carrots, more calcium than milk, more iron than spinach, more potassium than bananas, and more vitamin C than oranges. The leaves are considered to offer great potential for those who are nutritionally at risk and may be regarded as a protein and calcium supplement (Rajangam *et al.*, 2001). It is a fast growing, aesthetically pleasing tree. All parts of *moringa* are been consumed and used for various purposes, because of its impressive range of nutritional quality for humans and animals and its medicinal values. Despite considerable interest in the use of *Moringa oleifera* as a nutrient source, gaps and inconsistencies in the information on the nutrient composition of this interesting plant remain. There may be some reasons for this. The nutrient contents of plant could vary with soil and climate as well as the season and also the age of the plant. Sometimes, differences in the processing and storage procedures of seeds also may add more variations (Sabale *et al.*, 2008). For *moringa* leaves, additional variations could have been created over time due to errors created as nutrient composition values are incorrectly copied from source to source (Oliveira *et al.,* 1999). Thus, the research in nutrient compositions of *moringa* leaves may still be needed in academic circle, especially from one area to the other, from one soil to the other and from one climatic condition to the other.

All fruits, vegetables, legumes (beans and peas), and the grains we eat have nutritional values, so it is quite easy for people to include them in their diet. Some active ingredients isolated may have provided important components in the development of several lifesaving drugs, which are in use today. *Moringa* is a good source of important nutrient and thus, the plant might be explored as a viable supplement in both animal and human food (Anjorin *et al.*, 2010). That is the reason why it has provided jobs to some women who now act as middlemen between the *moringa* farm owners and some small scale industries that are processing and parking *moringa* as herbal medicine for sale. A milk tin of *moringa* seeds could fetch as much as ₦100 (22 pence) to the farmer.

Certain studies have provided scientific information to validate the nutritional and some health claims of *moringa oleifera.* They provided some scientific information on the nutritional, and functional properties of the *moringa* leaves which can serve as an impetus to those who wish to promote the use of the plants in agriculture (Madukwe, 2013; Siddhuraju

and Becker, 2003; Anthonia, 2002). However, whether the *moringa* leaves nutritional compositions are affected by different planting locations as a result of varying soil factors or as a result of some other environmental factors like ecological have not been much worked upon.

Locations determine the properties of soil in different places and this may leads to different compositions of the soil nutrients (Iqbal and Bhanger, 2006; Brady and Well, 2002) and then could lead to varying chemical constituents of the same plants grown on it. Environmental conditions in different areas could contribute to varying soil properties and varying compositions of the plants. In order to contribute to the growing body of knowledge on this subject, the present study is to analyze the impact of various locations in Osun and Oyo States of Nigeria on the nutritional constituents of *moringa* leaves to identify, isolate and quantify each proximate present in the plant material. This is to establish whether different locations have effect on the plant and farmers will therefore be able to select good and desirable soil (through soil analysis) before citing their *moringa* plantations.

MATERIALS AND METHODS

This study was carried out in the Agronomy Laboratory of Osun State University, Ejigbo Campus Osun State, as well as on the location fields where the materials were collected, as they were preserved carefully from there to the laboratory. Fresh leaves of *moringa oleifera* were randomly collected from sixteen different locations in Ejigbo and Egbedore LGAs of Osun State, and Surulere LGA of Oyo State, both States are in southwestern Nigeria.

*Sample Collection Areas***:** The various locations include 3 locations in Igbon and environs; 3 locations in Ara and environs; 1 location in Oke-Odo, Ejigbo; 2 locations in Ilawo, Ejigbo; 1 location in UNIOSUN, Ejigbo; 1 location in Palm Hotel, Ejigbo; 2 locations along Ifon Road in Oko and 2 locations in Oko town centre and 1 location at Iresaapa road, Oko. These numbers were specifically selected in relation to the sizes of each of the four principal areas, Igbon, Ara, Ejigbo and Oko and also in relation to the geographic entities of the research. The results of the study were then based on the principal four locations S1 for Ara, S2 for Igbon, S3 for Ejigbo and S4 for Oko. Soil samples analysis for the four different locations were done and the results are shown in Table 1.

Sample Preparation and Treatment: A stalk of *moringa* from its node may contain between 150 to 200 leaves depending on some environmental and ecological factors. At least 100 leaves from different stalks from a stand were carefully plucked randomly. Thus at least 300 leaves were plucked from three nearby trees at each location; they were mixed together as one. Prior identification and authentication of these separately collected leaves were done in the laboratory, Osun State University, before their scientific analyses.

The leaves of each plant were oven dried and then grounded into powder form. The powdered leaves were then stored into an airtight container and protected until required for analysis. All chemical reagents were of analytical grade and all determinations were done in triplicate and results were reported on dry weight basis.

The proximate compositions of the samples were analysed chemically for its moisture, crude protein, crude fat, crude fibre, crude ash, and carbohydrate contents according to the methods of the Association of Official Analytical Chemist (AOAC. 2005). The materials and apparatus used were oven, crucibles, desiccators and weighing balance, silica gel and grease.

Sample Analysis: Moisture Determination: 2kg of the sample was weighed into a previously weighed crucible, W_o. The crucible plus sample, W_1, was then transferred into the oven set at 100^{o}C to dry to a constant weight for 24 hours overnight. At the end of 24 hours, the crucible plus sample was removed from the oven and transferred to desiccators, cooled for ten minutes and weighed, W_3

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$$\%\ \text{DM} = \%\ \text{Dry matter} = \frac{W_3 - W_0}{W_1 - W_0} \times 100 \quad \text{and} \quad \%\ \text{moisture} = \frac{W_1 - W_3}{W_1 - W_0} \times 100 \quad \text{or} \quad \%\ \text{moisture} = 100 - \%\ \text{DM}$$

Among the precautionary measures taken was accurateness in the drying processes. The sample was dried to constant weight and it was closely monitored so as not to have anything to distort precautionary measures that were taken.

Crude protein determination: The crude protein in the sample was determined by the semi-micro Kjeldahl procedure. This consists of three techniques of analysis namely, digestion, distillation and titration. Using analytical balance, digestion block heaters, digestion tubes, 50ml burette, 5ml pipette, 10ml measuring cylinder, fume cupboard, 100ml beakers with reagents 0.01NHCl, concentrated H_2SO_4, 2% Boric acid solution, 40% (W/V) NaOH, Methyl red- Bromosol green mixed indicator, Kjeldahl catalyst indicator were used, the three methods were done successively to evaluate crude protein. Among the precautionary measures taken was that all these chemicals were obtained from the laboratory where they were kept as scientifically adequate as possible and in accordance with global standard.

Crude fat or ether extracts determination: using oven, desiccators, soxhlet apparatus and accessories and analytical balance with reagents: ether or petroleum spirit (40^o - 60^o b.pt) ether contents were determined. If the initial weight of dry soxhlet flask was W_0 and the final weight of oven dried flask + oil/fat was W_1, then percentage fat/oil would be:

$$\frac{W_1 - W_0}{\text{Weight of the sample taken}} \times 100$$

Determination of ash: desiccators, porcelain crucibles, analytical balance and a furnace were used to determine ash content. The percentage ash was calculated from the formula

$$\text{Ash content (add unit)} = \frac{\text{weight of ash}}{\textit{original}\ \text{weight of the sample}} \times 100$$

Crude fibre determination: using crucibles, desiccators, heating mantle, sieve cloth, furnace, funnel, fibre flask, analytical weighing balance with reagents 0.25N H_2SO_4, 0.313N NaOH and Acetone, percentage fibre was obtained by the formula

$$\%\ \text{Fibre} = \frac{W_1 - W_2}{\textit{weight of}\ \text{sample}} \times 100$$

Statistical analysis: The data collected were subjected to two-way Analysis of Variance (ANOVA) using a statistical package by CoStat (CoHort Software 2014). Mean values that were significant were separated using Least significant difference (LSD) at $P \geq 0.05$. The linear associations were measured using Pearson Product Moment Correlation Coefficient.

RESULTS AND DISCUSSION

Different characteristics of the soil samples collected from various points from each of the selected locations in the research are shown in Table 1.

Table 1: Soil characteristics- chemical and physical characteristics at different locations

Soil Parameter	Ara	Igbon	Ejigbo	Oko
Chemical characteristics				
pH (H_2O)	6.25	7.20	6.63	6.36
Organic carbon (%)	1.42	1.37	1.14	1.10
Organic matter (%)	1.20	2.37	0.92	1.14
Available P (ppm)	14.82	1.05	15.86	16.54
CEC, (meg/100g)	7.2	8.3	7.6	7.0
K (Cmol/kg)	1.33	1.0	1.03	1.13
Ca (Cmol/kg)	1.40	1.20	1.42	1.36
Mg (Cmol/kg)	1.90	1.28	1.90	1.82
Nitrogen(%)	0.36	0.43	0.34	0.32
Physical characteristics				
Sand (%)	64.50	87.56	68.90	66.70
Silt (%)	18.04	10.44	20.05	20.50
Clay (%)	17.46	2.00	11.05	12.80
Textural class	sandy loam	sandy loam	sandy loam	sandy loam

Mean values of moisture, crude protein, crude fat, crude fibre, ash and carbohydrate of *moringa* leaves from the various locations shown in Figures 1 – 3, also Table 3 was arrived at when the raw proximate values were compared using the Least Significance Difference at 0.05 Level of probability.

Moisture contents: Moringa leaves from Ejigbo recorded the lowest moisture content at 28.85%. There was no significant difference in the moisture content of *moringa* leaves from Ara (S1) and Igbon (S2) but numerically, Oko had the highest value of 38.76%, Figure 1. The crude protein in the *moringa* leaves obtained from the different locations recorded similar mean values showing no significant difference at $p < 0.05$, this was also the earlier findings of Oduro *et al*., (2008). There were statistical differences between the values recorded for moisture contents in the harvested leaves at various locations, Table 2. The leaf samples from the Oko locations recorded higher moisture content; this could be because of the soil that have more organic matter (1.14) that could add more sap to the crop, Table 1.

Crude fat: The crude fat in the *moringa* leaves obtained from Ara and Igbon recorded the highest value at 11.8% and 11.13% respectively. Oko recorded a high average value of crude fat at 8.64%, Figure 2. The *moringa* leaves from Ejigbo recorded the lowest value at 6.5%. There were statistical differences in crude fat among all the locations at $p < 0.05$ except between S1 and S2, Table 2. More phosphorus was found in soils in Oko (S4) than other locations in the research, it may be because of this that the leaves of *moringa* could do well

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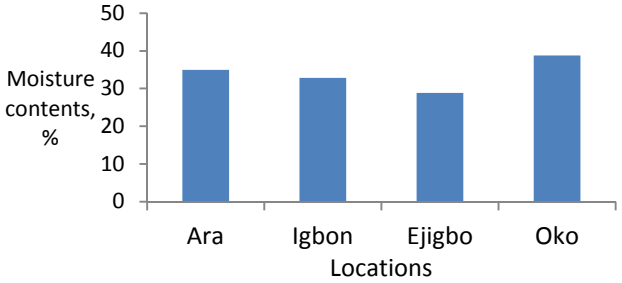

Fig 1: Moisture contents variations at different locations

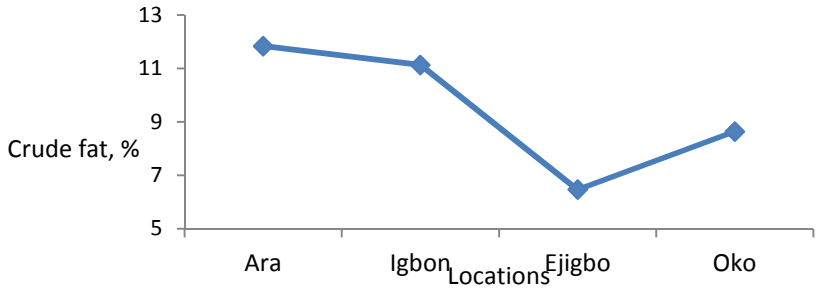

Fig 2: Effects of different locations as depicted in varying crude fat values in *moringa* leaves.

Table 2: Proximate contents of *moringa* leave powder collected from various locations.

Locations	Moisture%	Crude Protein%	Crude Fat%	Crude Fibre%	Ash%	Carbohydrate %
S1	34.95ab±2.44	27.64a±1.09	11.83a±0.60	12.42a±0.86	9.59b±1.01	38.51b±2.23

S2	32.80ab±1.31	25.27a±1.60	11.13a±0.66	12.09a±0.58	12.4a±0.72	39.77b±1.30
S3	28.85b±2.84	23.93a±0.37	6.47c±0.57	9.84b±0.46	9.87ab±0.03	49.90a±1.13
S4	38.76a±2.44	24.33a±0.38	8.64b±0.32	9.39b±0.46	9.21b±0.35	48.44a±0.62

Mean values with the same superscript are not significance at $p<0.05$

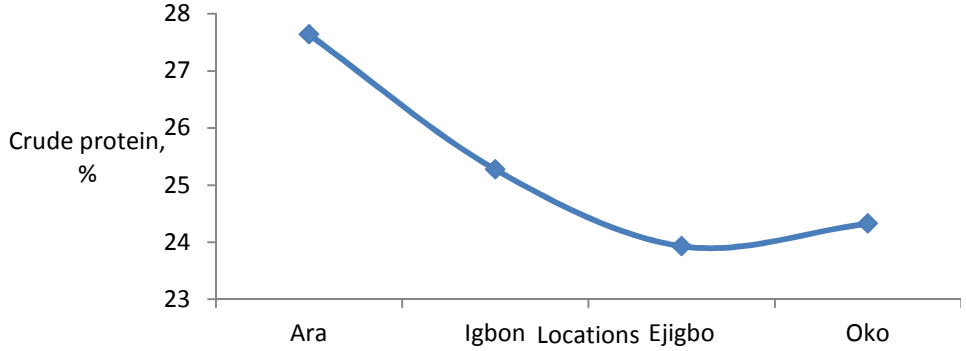

Fig 3: Effects of different locations as revealed in varying crude protein values in *moringa* leaves.

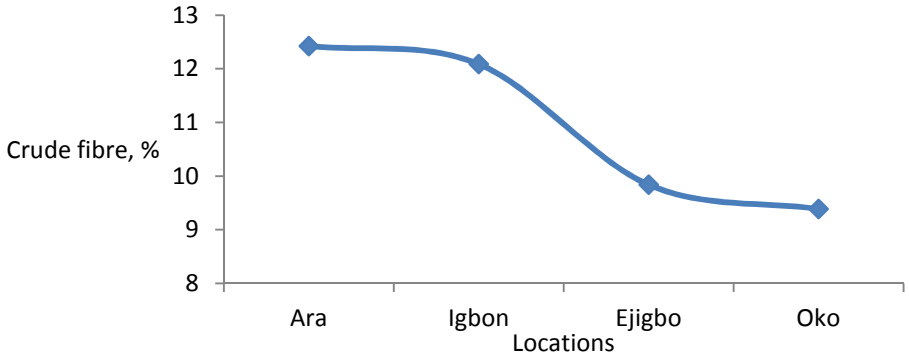

Fig 4: Different locations versus varying crude fibre of *moringa* leaves.

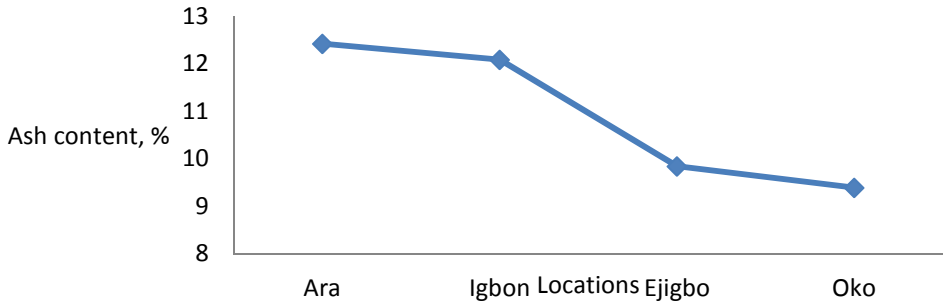

Fig 5: Effects of different locations as revealed in varying ash contents in *moringa* leaves.

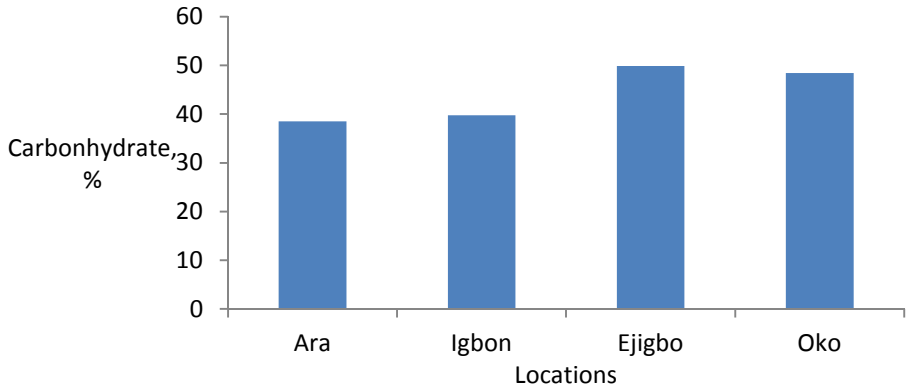

Fig 6: Effects of different locations as shown in varying carbonhydrate values of *moringa* leaves.

Samples from the four locations recorded a crude fat content ranging from 6.5-11.83%, Table 2. The amount of fat at each location indicates that this plant cannot be a source of lipid accumulation which can cause arteriosclerosis and aging in man (Makkar and Becker, 1996). It is very low when compared to *Talinum triangulare* (5.90%), *Baseila alba* (8.71%), *Amaranthus hybridus* (4.80%), *Calchorus africanum* (4.20%), *Acalypha racemosa* (6.30%) (Oduro *et al*.,2008). The low fat characteristic of *moringa* leaves has been previously reported by Makkar and Becker (1997, 1996).

Crude protein: There was no statistical difference in the crude protein content of the *moringa* leaves obtained from the various locations ranging from 23.9 to 27.64 % of the weight of the leaves, Table 2. The range therein could be surmised to be as a result of higher CEC recorded which is the capacity of the soil to exchange cations/anions or simply the soil's ability to release its nutrients. The *moringa* leaves contained appreciable amount of crude protein content making it to be a good source of supplementary protein for man and livestock. Appreciable level of crude fibre in *moringa* leaves is acceptable as it prevents the occurrence of diseases thereby promoting good health.

Other similar studies concerning the proximate analysis of *moringa* leaves have reported different values for the protein content of *moringa* leaves ranging from 16-40%. They compared favourably with *Amaranthus caudatus* (20.59%), cassava leaves (*Manihot utilisima*), 24.88%, *Piper guineeses* 29.78% and *Talinum triangulare* 31.00%. The results also showed that *Moringa* leaves contain nutritious compounds. The high protein characteristic of *Moringa* leaves has been previously reported by Makkar and Becker (1997, 1996). These results are in agreement with the values reported by Fugile (2001, 1999) and Oduro *et al*., (2008).

Crude fibre: There was significant difference in the crude fibre levels recorded among Ara, Igbon, Ejigbo and Oko at 12.4%, 12.1%, 9.84%, 9.4% respectively, Figure 4. There was statistical difference in the percentage of crude fibre among the various locations. Crude fibre has been reported to cleanse digestive tract by removing potential carcinogens from the body and hence prevents the absorption of excess cholesterol. In addition, fibre adds bulk to food and reduces the intake of excess starchy food which is the characteristic of the diet of the poor and local people and hence guard against metabolic conditions such as hypertension and diabetes mellitus in them.

Ash content: The ash content in the *moringa* leaves also recorded a slightly significant difference among Igbon, Oko, Ejigbo, Ara at 11.7%, 9.21%, 9.9%, 9.6% respectively, Figure 5. Ara location recorded highest organic carbon (1.42) while Igbon recorded the highest nitrogen (0.43); these observations were supported by the high contents of both the ash and the crude fibre found in *moringa* leaves from the locations.

Carbonhydrate content: Moringa leaves obtained from Ejigbo recorded the highest carbohydrate content of 49.9% followed by Igbon with 48.4%. *Moringa* obtained from Ara recorded carbohydrate content of 38.5% and there was a significant difference in the carbohydrate contents among the four locations. The results obtained from proximate analysis of the *moringa* leaves established that they can be ranked as carbohydrate rich leaves due to their relatively high content when compared with the other component of the leaves as shown in Figure 6. Sufficiency of carbohydrate is however necessary for

optimum functioning of the brain, heart, nervous, digestive and immune systems. Samples from the four locations had carbohydrate content ranging from 38.5 to 49.9% of the weight of the leaves, Table 2. Since leaves from Ejigbo recorded the highest carbohydrate content, it could be because of the nature of the soil as shown in Table 1.

Soils in Igbon was acidic, it could be because of this that the carbohydrate content was low. The variations in nutritional composition of the dried *moringa* leaves analyzed could be attributed to the difference in genetic makeup of the plant and varying soil factors. The soil layers in these areas were different although not too distinct, Table 1.

Association among the locations and the nutrient composition of moringa leaves: Table 3 revealed the whole number of relationship in virtually all the locations S1, S2, S3 and S4. There are some levels of significance and non-significance, ns, as shown in the Table and the closeness of some of their values. This could mean that there are nearly perfect matches among the nutritional components worked upon and at the different locations of the *moringa*. Also, it could be surmised to mean that there could be some levels of significant differences among the leaves from one place to the other. In Table 3, Ejigbo (S3) had moisture content that showed significant positive association (1.00) with crude protein% and significant negative association (-1.00) with carbohydrate. This could be surmised to mean that if the moisture contents of the leaves at harvest is high, the crude protein will also be high but the carbohydrate will be low, thus suggesting that proper drying should be applied to maintain the level of protein in the leaves. Similarly, moisture content at Ara, (S1), moisture content had significant negative correlation with ash content, thus as moisture content of the leaves harvested there increases, the ash content decreases, this could be as a result of the soil organic matter contents that was low in Ara (1.20). Such condition did not happen with the leaves harvested in Igbon, (S2) because of its high organic matter (2.37).

In addition, carbohydrate had significant negative association with crude protein at Ara (S1) and Ejigbo (S3) with -1.00 each. This implies that *moringa* leaves harvested at these locations require appropriate drying to maximize the crude protein content in the leaves. Another factor that could have contributed to these findings in these leaves harvested at different locations could be the soil characteristics (Table 1), high organic matter (1.20) and nitrogen content (0.36) in Ara (S1) might have contributed to the observed associations.

Conclusion: Various soil factors have varying effects on the composition of *moringa* leaves from locations to locations. The farmers when aware of this should know that good site selection based on scientific analysis of the soil will help to establish their *moringa* plantation in a desirable field. The choice will now depends on the individual as it is a potential leaf source of food; that is, suitable for fortification of foods and their use as nutritional supplements. Farmers can treat the soil not only at planting but even during growing.

Table 3: Association among proximate contents of *moringa* leaves' powder obtained in different locations

Parameters	Locations	Moisture %	Crude Protein%	Crude Fat %	Crude Fibre%	Ash%	Carbohydrate %
Moisture%	S1	1	-0.89±0.30^{ns}	-0.98±0.14^{ns}	0.68±0.53^{ns}	-1.00±0.01*	0.89±0.30^{ns}
	S2	1	-0.89±0.30^{ns}	-1.00±0.13^{ns}	0.71±0.51^{ns}	0.99±0.10^{ns}	0.73±0.48^{ns}
	S3	1	1.00±0.03*	1.00±0.11^{ns}	0.94±0.23^{ns}	-0.17±0.89^{ns}	-1.00±0.04*
	S4	1	-0.92±0.26^{ns}	-0.45±0.71^{ns}	0.84±0.36^{ns}	-0.99±0.09^{ns}	0.73±0.48^{ns}
Crude Protein%	S1		1	0.78±0.43^{ns}	-0.28±0.82^{ns}	0.90±0.28^{ns}	-1.00±0.00**
	S2		1	0.79±0.43^{ns}	-0.31±0.80^{ns}	-0.95±0.20^{ns}	-0.96±0.18^{ns}
	S3		1	0.99±0.08^{ns}	0.92±0.26^{ns}	-0.12±0.92^{ns}	-1.00±0.01*
	S4		1	0.05±0.97^{ns}	-0.99±0.10^{ns}	0.85±0.35^{ns}	-0.39±0.74^{ns}
Crude Fat%	S1			1	-0.82±0.39^{ns}	0.97±0.15^{ns}	-0.77±0.45^{ns}
	S2			1	-0.83±0.37^{ns}	-0.94±0.23^{ns}	-0.58±0.60^{ns}
	S3			1	0.87±0.33^{ns}	-0.00±1.00^{ns}	-1.00±0.07^{ns}
	S4			1	0.11±0.93^{ns}	0.56±0.62^{ns}	-0.94±0.23^{ns}
Crude	S1				1	-0.67±0.54^{ns}	0.27±0.82^{ns}

Fibre%	S2	1	0.59±0.60^{ns}	0.04±0.98^{ns}
	S3	1	-0.50±0.67^{ns}	-0.91±0.27^{ns}
	S4	1	-0.76±0.45^{ns}	0.25±0.84^{ns}
Ash%	S1		1	-0.9±0.29^{ns}
	S2		1	0.83±0.38^{ns}
	S3		1	0.11±0.93^{ns}
	S4		1	-0.82±0.39^{ns}
Carbohydrate	S1			1
%	S2			1
	S3			1
	S4			1

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