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Effect of Soil Type on the Nutritional Quality of Groundnut (*Arachis hypogaea* L) in Burkina Faso

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ABSTRACT

Background: Groundnut is an important food crop in West Africa. It is an oilseed that provides food and nutritional security for many populations. The objective of this study was to determine the effect of different soil types on the nutritional quality of groundnut.

Methods: This study was done in the village of Lebda located in the Centre-North region of Burkina Faso. The methodology consisted of collecting groundnut seeds of the SH 470 P variety from fourteen farmers according to three types of soil and determining macronutrient and mineral contents.

Result: Analyses of variance showed significant differences between soil types for fat, carbohydrate and iron content. Clay soils showed high fat contents, 46.6%±6.3 g/100 g dry matter. While gravelly soils showed peanut seeds with high carbohydrate contents, 18.8±1.9 g/100 g of dry matter. Iron content varied from 1.9±0.5 mg/100 g dry matter on sandy soils to 2.46±0.39 mg/100 g dry matter on clay soils.

Key words: Groundnuts, Nutrients, Soils, Texture.

INTRODUCTION

Groundnut is an important food crop ensuring food and nutritional security for many populations in West Africa. In Burkina Faso, it is the second most important legume produced with nearly 396,129 tonnes in 2020 (MAAHM, 2021). The peanut plant comes from South America and is well adapted to the climatic conditions of arid zones such as those of sub-saharan Africa (Sharma and Mathur, 2006; Bertioli *et al*., 2011). Peanut seed is an important source of protein, calories, fatty acids and minerals for humans (Willett *et al*., 2019). It also has health benefits (Kris-Etherton *et al*., 2008; Sabate *et al*., 2010; Guasch-Ferré *et al*., 2017). It is the main legume in infant food formulations. For the community-based treatment of severe malnutrition, the United Nations World Health Organization encourages the consumption of peanut-based “ready-to-use therapeutic foods” (RUTFs). This is the case, for example, with Plumpy’Nut, which is used for the treatment of severe acute malnutrition. Peanuts have many uses, from plain consumption to peanuts and peanut paste, which is widely used in sauces. Poor soil health, drought, poor post-harvest conservation practices are the main problems limiting groundnut availability (Pitt *et al*., 2013; Njoroge *et al*., 2017). Peanut grows on soils rich in macronutrients (N, P, K, Ca, S, Mg) and micronutrients (Fe, Mn, Zn, Cu, B, Mo) and with well-defined pH (Singh and Chaudhari, 2006; Rajitha *et al*., 2018). Phosphorus supplementation increases groundnut yield (Mupangwa and Tagwira, 2005; Kamara *et al*., 2011) while potassium deficiency in the soil leads to an inability to use nitrogen and water and increased susceptibility to diseases. Soil condition has a strong influence on peanut seed yield. Soil texture affects soil fertility and how air and water move through the soil. The relationship between soil and nutritional value of groundnut is important for the selection of groundnut seed. There are very few studies that have looked at the relationship between soil and nutritional quality of groundnut. The objective of the present study is to identify the soil type for optimising the nutritional quality of groundnut seed.

A knowledge of soil types for good nutritional quality of groundnut seed is very useful for producers and policy makers.

MATERIALS AND METHODS

The plant material is the groundnut variety SH470 P. It was supplied by the farmers of the Minim Sompanga Association of the Centre-North region of Burkina Faso (AMSP).

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Study area

The study was conducted in Lebda. Lebda is located 25 km southwest of Pissila, the county town and about 15 km southeast of Kaya, the north centre region capital. The geographical coordinates are 13 02′ 11″ north, 0°57′ 26″ west. It has a warm and dry claimt. The rainy season is from June to September and is the growing season

Collection of samples

The seedlings were planted in July 2019. Three types of soil were identified in the village of Lebda according to their constitution: sandy, clayey, gravelly. On each soil type, five plots were sown with the SH470P variety by AMSP farmers with good experience in groundnut production. Only four plots were planted on clay soils, making a total of fourteen plots. No fertiliser was added to any of the identified soils. Table 1 presents the characteristics of the soils in the study according to toposequence and field type. Harvesting took place in October and the seeds were transported to the laboratory.

Sample preparation

On each type of crop, about 200 grains were collected, cleaned and then ground using a stainless steel IKA grinder. The flours obtained were kept in sterile jars and stored in the refrigerator at 4°C for the various analyses.

Biochemical analyses

The water content of the samples was determined by differential weighing of a 5 g sample before and after oven drying at 130°C for 2 h according to the French standard NF V 03-707, 2000. The total ash content was determined by differential weighing after the samples had been baked overnight according to the French standard "ISO 2171:2007".

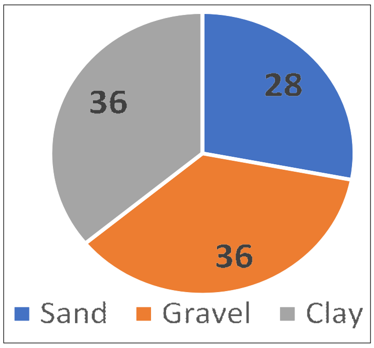

Fig 1: Number of groundnut farmers by soil type (%)

The protein content was determined by the Kjeldahl method according to the AFNOR NF V03-050. The conversion factor considered is 6.25. The lipid content was determined according to the ISO-659 standard with the Soxhlet extraction method. The carbohydrate content was calculated (Egan *et al.* 1981) according to the formula:

Carbohydrate content (%) =

100 - [protein (%) + fat (%) + ash (%) + water (%)]

The iron and zinc contents were determined by flame atomic absorption spectrometry according to the AOAC method.

Statistical analysis

The nutritional analysis were performed in triplicate for each sample and an average was calculated. Data processing of the biochemical analysis was done using Excel and XLSTAT version 7.5.2. Analysis of variance (ANOVA) was used to compare the means of the different parameters between the samples. The Fisher test at the 5% threshold was used to compare the means when the ANOVA revealed significant differences.

RESULTS AND DISCUSSION

Fat is an important component of the groundnut seed from which oil is extracted for food. Groundnut seeds from clay soils had the highest fat and iron contents, respectively 46.6%±6.3 g and 2.4 mg per 100 g of dry matter. Clay soils have the advantage of having high water retention and availability capacities; in addition, sediment deposition is more important, which could explain the high iron and lipid contents in groundnut seeds from these soils. Clay minerals play an important role in phosphorus absorption and availability.

However, groundnut seeds from clay soils have the lowest carbohydrate content of 14.3±1.9 g/100 g dry matter. Carbohydrates give the sweet taste to some peanut varieties that are highly valued for processing into peanuts or eaten plain.

The results of this study showed that soil type has a significant effect on the ash, fat, carbohydrate and iron contents of peanut seeds. Clay soils have the advantage of interesting physical properties in terms of high-water retention and availability; in addition, sediment deposition is higher, which could explain the high iron and lipid contents in groundnut seeds from these soils.

Groundnut farming techniques by soil type, topo sequence and field type

Fig 1 presents the farming techniques for groundnuts in Lebda according to soil type, toposequence and field type. With regard to soil type, the results of the survey show that

Table 1: Summary of the soil types in the study.

Type of soil	Number of farmers	Situation topo séquence			Type of field	
		Bottom of the slope	Top of slope	No gradient	Bush	Village
Sandy	5	2	2	1	2	3
Gravel	5	1	3	1	2	3
Clay	4	3	0	1	3	1
Total	14	6	5	3	7	7

groundnut growers cultivate on three types of soil, namely sandy, gravelly and clayey. These three types of soil are characteristic of the soil conditions in the growing area. It should also be noted that groundnuts are a crop that does not require large amounts of water for its development. This makes its cultivation more successful on soils that retain very little moisture (sandy and gravelly soils) as opposed to soils that have a high water retention capacity such as clay soils.

According to the toposequence, 42.86% of farmers cultivate groundnuts at the bottom of the slope, 35.71% at the top of the slope and 21.43% in the absence of slope. With regard to field types, the results of the survey showed that half of the producers, *i.e.* 50%, cultivate in bush fields. The lower slope is preferred by producers to compensate for the pockets of drought that have become more and more recurrent in recent years. The lower slope allows for a longer retention of soil moisture compared to other types of slopes. In addition, there is no preferred type of field for groundnut cultivation, it is grown according to the available land.

Effect of soil type on nutritional parameters of groundnut seeds

Table 2 shows the macronutrient and micronutrient (iron and zinc) contents of groundnut seeds according to soil type. Analyses of variance showed significant differences by soil type for ash, fat, carbohydrate and iron content. However, soil type had no effect on protein and zinc content.

The average ash content of groundnut seeds varied from 2.15±0.11 g/100 g dry matter on clay soils to 2.30±0.15 g/100 g dry matter on sandy soils. The fat content varied from 40.64±1.92 g/100 g dry matter on gravelly soils to 46.58± 6.37g/100 g dry matter on clay soils. The average carbohydrate content of groundnut seeds varied from 14.34 ±5.02 g/100 g dry matter on clay soils to 18.86±1.90 g/100 g dry matter on gravel soils. Iron levels varied from 1.97±0.56 mg/100 g dry matter on sandy soils to 2.46±0.39 mg/100 g dry matter on clay soils. The average ash content of groundnut seeds from sandy soils was the highest (2.30 g/ 100 g dry matter); this similar to that found by Knoden *et al*. (2003) which was 2.3 g/100 g dry matter for seeds of the runner variety. The average lipid content of groundnut seeds from clay soils is lower (46.58±6.37 g/100 g dry matter) than that obtained by Knoden *et al*. (2003), which was 47.5 g/100 g dry matter, but higher than that reported by local nutritional composition table (Direction de la Nutrition, 2005), which was 44.8 g/100 g dry matter

The average carbohydrate content of peanut seeds from gravelly soils (18.86 g/100 g DM) is similar to that obtained by Knoden *et al*. (2003) which was 18.6 g/100 g dry matter and lower than that given by the local nutritional composition table (Direction de la Nutrition 2005) food composition table which was 23 g/100 g dry matter.

The average iron content of groundnut seeds from clay soils (2.46 g/100 g dry matter) is lower than that reported by local nutritional composition table (Direction de la Nutrition 2005) which was 3.8 mg/100 g dry matter.

The results of this study showed that soil type has a significant effect on the ash, lipid, carbohydrate and iron contents of groundnut seeds. Clay soils have the advantage of interesting physical properties in terms of high water retention and availability (Agbé, 2007); in addition, sediment deposition is higher, which could explain the high iron and lipid contents in groundnut seeds from these soils.

Effect of toposequence on nutritional parameters of groundnut seeds

Table 3 presents the macronutrient and micronutrient (iron and zinc) contents of groundnut seeds by toposequence. Analyses of variance showed significant differences by toposequence for ash and zinc content. However, toposequence had no effect on protein, lipid, carbohydrate and iron content.

The average ash content of the peanut seeds varied from 2.03±0.07 g/100 g dry matter on the flat land to 2.30± 0.12 g/100 g dry matter on the steep land. Zinc content varied from 3.96±0.23 mg/100 g DM in the flat areas to 4.84±1.46 mg/ 100 g dry matter in the high slope areas.

The average ash content of groundnut seeds from the high slope land was the highest (2.30±0.12 g/100 g dry matter); it is higher than those reported by similar to that found by Knoden *et al*. (2003) which was 2.3 g/100 g dry matter for seeds of the runner variety.

The average zinc content of groundnut seeds from the upper slopes was the highest (4.84±1.46 mg/100 g dry matter) and is higher than that reported in the local nutritional

Table 2: Biochemical composition of peanut seeds by soil type (per 100 g dry matter).

Parameters	Types of soil		
	Sand	Gravel	Clay
Minerals content(g)	2.3±0.1	2.2±0.13	2.1±0.1
Protein content (g)	32.9±1.5	34.3±1.14	33.1±2.2
Fat content (g)	45.0±4.8	40.6*±1.9	46.6 ±6.3
Carbohydrates content (g)	15.7±4.2	18.8*±1.90	14.3±5.0
Iron content (mg)	1.9*±0.5	2.1±0.6	2.4±0.3
Zinc content (mg)	4.7±1.4	4.0±0.5	4.1±0.2

The sign * means that there is a significant difference in the value compared to the values in the same row. The confidence level is 95%.

Table 3: Macronutrient and mineral composition of peanut seeds by toposequence (expressed per 100 g dry matter).

Parameters	Top of the slop	Bottom of the slop	No gradient
Protein content(g)	33.9±1.3	33.2±2.0	33.2±1.4
Fat content (g)	42.41±3.0	43.6±6.1	47.0*±4.4
Carbohydrates content (g)	17.4±3.5	17.2±4.2	14.0*±3.8
Iron content (mg)	2.3±0.7	1.9*±0.3	2.4±0.4
Zinc content (mg)	4.8±1.4	4.01±0.3	3.9±0.2

The sign * is assigned when there is a significant difference from the other values.

composition table (Direction de nutrition, 2005) which was 3.8 mg/100 g dry matter.

Groundnut seeds from the upper slopes are rich in zinc. Depending on the toposequence situation, fat, carbohydrate and iron contents are affected. Lipid contents are significantly higher in groundnut seeds grown on soils without denivellation. Iron contents of groundnut seeds are low on the lower slopes.

CONCLUSION

This work provided information on the effect of soil types on the nutritional quality of groundnuts (*Arachis hypogaea* L.) produced in Burkina Faso. Groundnut seeds grown on clay soil are richer in fats and iron; groundnut seeds grown on sandy soil are richer in total ash and groundnut seeds grown on gravelly soil are richer in protein. According to the toposequence situation, groundnut seeds from the upper slopes are richer in zinc.

In summary, the nutritional quality of groundnut seeds is influenced by factors such as soil type and topo sequence.

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