International Journal of Sustainable Agricultural Research
2022 Vol. 9, No. 1, pp. 18-27.
ISSN(e): 2312-6477
ISSN(p): 2313-0393
DOI: 10.18488/ijsar.v9i1.2940
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EFFECT OF DIFFERENT SOIL TREATMENTS ON THE QUALITY OF SOYBEAN FLOUR AND MILK

Omah, E. C.[1+]
Azuka C. V.[2]
Obiorah K. C.[3]

[1,3]*Department of Food Science and Technology, University of Nigeria, Nsukka, Enugu State, Nigeria.*
[1]*Email: esther.omah@unn.edu.ng Tel: 08064445115*
[3]*Email: obiorahkingsley9@gmail.com Tel: 09057406315*
[2]*Department of Soil Science, University of Nigeria, Nsukka, Enugu State, Nigeria.*
[2]*Email: chukwuebuka.azuka@unn.edu.ng Tel: 08060546849*


(+ Corresponding author)

Article History
Received: 3 January 2022
Revised: 15 February 2022
Accepted: 1 March 2022
Published: 21 March 2022

Keywords
Soybeans
Soymilk
Soil treatment
Functional properties
Chemical composition
Sensory.

ABSTRACT

The study investigated the influence of fertilization treatments and tillage on the quality of soybean flour and milk samples. The fertilization treatments were as follows: 10t/h (4.5kg) organic; 5t/ha (2.25kg organic + 50%NPK 15:15:15); 15t/ha (6.75kg organic + 50% NPK 15:15:15); 10t/ha (4.5kg + 50% NPK 15:15:15); 100% NPK 15:15:15 and control (no treatment). These applications were made on tilled and non-tilled soils respectively and cumulated to sample codes T1, T2, T3, T4, T5, T6, NT1, NT2, NT3, NT4, NT5 and NT6. The soybean samples were milled and the samples were subjected to functional and chemical analyses. These samples were used to produce soymilk which was subjected to sensory evaluation. The functional properties results for bulk density, swelling capacity, water absorbing capacity (WAC), foaming capacity and pH ranged from 0.54-0.69%, 87-248%, 0.65-1.45%, 5.45-31.70% and 5.90-6.40 respectively. Proximate composition of the samples ranged from 6.32-11.33% moisture, 26.45-49.65% protein, 15.09 -18.65% fat, 4.69-8.22% ash, 5.05-13.73% crude fibre and19.95-32.40% carbohydrate. The mineral composition ranged from 32.30 – 49.56 mg/100g, 0.05 – 0.07 mg/100g and 0.04 - 0.35 mg/100g for calcium, iron and potassium respectively. The vitamin content ranged from 1.19 – 2.52mg/100g, 0.18-0.39mg/100g, 0.01 - 0.03mg/100g and 9.80-13.41 mg/100 for B1, B2, B12 and B6 respectively. The anti-nutrient result for phytate, trypsin inhibitor and heamaglutinin ranged from 0.11-0.20 mg/100g, 0.05-0.13 mg/100g and 0.56-1.44 Hu/gm respectively. Samples obtained from tilled soil showed best results. Sensory results of the soymilk showed improved attributes when compared to the control samples.

Contribution/Originality: There is dearth of information on the influence of fertilizer application, tillage and non-tillage of soil on the nutrient composition of soybeans and sensory properties of its product. The study therefore highlights the possibility of quality variability of soybeans as a result of applied soil treatments.

1. INTRODUCTION

The production and utilization of soybean as food began in ancient china around 11th century B.C. The continued existence of china as a nation is attributed by historians to her use of soybean as food. It is strongly related with the history of china where it had been about the only supply of proteins for generation (Qiu & Chang, 2010). The crop however became grown in other parts of the world in the 20th century. It was first introduced in Europe in the 1700s and in America in 1804 (Willis, 2021). Soybean has progressively become more important agricultural commodity, in the past several decades, having a steady increase in annual production in the United

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States and the world. There have equally been conscientious efforts to introduce the crop in poorer regions with marginal malnutrition (Iwe, 2003). Soybean is mainly cultivated for its seeds, usually commercially as human food and livestock feed, and for the extraction of oil. For thousands of years, the Chinese and the people in neighbouring countries consumed soybean in various forms of traditional soy foods such as tofu, soy sauce, miso (jiang in Chinese), soy sprouts, green vegetable soybean, etc. The bean is a valuable economic agricultural commodity which has favourable agronomic characteristics, including good adaptability to a wide range of soil and climate (Iwe, 2003). It also has the ability to fix nitrogen, which makes it a good rotation crop for use with high-nitrogen-consuming crops, such as corn and rice (Liana & Goldsmith, 2020). Soybean also has a unique chemical composition on an average dry matter basis; and it contains about 40% protein and 20% oil. It is also nutritious; the protein and oil components in soybeans are high not only in quantity but also in quality (Dixit, Antony, Sharma, & Tiwari, 2011). Soybean is one of the most important grains and oil crop in the world, therefore the environmental condition of the soil in soybean growing should receive important attention in agricultural policies. Quite a number of researches carried out have shown that quality of crops is greatly determined by several factors including soil treatments. For instance increase of soil acidity accelerates the loss of essential elements such as K, Ca, and Mg, decreases the soil cation exchange capacity and affects the geochemical cycle of soil nutrient in growing soybean. The pH and organic matter are important indicators of the soil environment, which can affect the absorption of trace elements in crops, thus affecting the crop yield and quality (Peter, Brüggemann, Meissner, Seeger, & Wennrich, 2010). The quality of the soil environment is directly related to the safety of agricultural products, and ultimately affects human health and the sustainable development of society (Liu, Wang, & Peng, 2002) Much scientific work have also been done on the merits and demerits of tillage and no- tillage systems on crop growth, development and yield. According to Hillel and Hatfield (2005), the traditional aims of tillage are to improve soil structure for crop growth, incorporate organic amendments into the soil, and to control weeds. The last goal can often be met by use of herbicides, and this has led to the development of no-tillage systems, where tillage is confined to soil disturbance associated with crop seeding or planting. Soil tillage is also involved in soil-water conservation and regulation, and in soil-erosion control. Conventional tillage is expected to have a positive effect on soil physical properties, soil carbon storage, while reducing labour cost. However, reduced tillage or non- tillage could increase soil nitrous oxide (N_2O) (Zurovec, Sitaula, Custović, Zurovec, & Dörsch, 2017). However, there is dearth of information on tillage effect on quality of harvested soybean and its products.

2. MATERIALS AND METHODS

2.1. Materials

The soybean seeds (Glycine max), were obtained from an experimental farm at the Faculty of Agricultural Science, University of Nigeria, Nsukka. Ingredients for soymilk production were purchased from the Ogige market, Nsukka, Enugu State, Nigeria. Chemicals and reagents used were procured from certified Laboratory chemical dealers in Nsukka.

2.2. Identification of Samples

The soybean seed was identified according to the treatments given to the soil on which they were planted. The soil treatments are shown in Table 1.

2.3. Soymilk Preparation

Two kilogram (2kg) of soybean seeds was cleaned by sorting and winnowing to remove stones and debris. The cleaned grains were soaked in tap water three times its weight by volume for 8 hours. The seeds were dehulled using mortar and pestle by gentle pounding to dislodge the seed coats. The dehulled kernels were washed with tap water, boiled for 15 minutes, washed with tap water and milled into paste while water was added in ratio of 1:2. The

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slurry was sieved using cheese cloth and the recovered milk was cooked for 20 minutes at 100°C.Sugar and flavor were added to improve taste. The milk was homogenized using a blender and cooled to 25°C. Figure 1 shows the flow diagram for the preparation of soymilk.

Table 1. Different soil treatments used in cultivating the soybean seeds.

Sample source code	Soil treatments
T1	10t/ha (4.5kg)
T2	5t/ha (2.25kg + 50%NPK 15:15:15)
T3	15t/ha (6.75kg + 50% NPK 15:15:15)
T4	10t/ha (4.5kg + 50% NPK 15:15:15)
T5	(100% NPK 15:15:15)
T6	Control
NT1	10t/ha (4.5kg)
NT2	5t/ha (2.25kg + 50%NPK 15:15:15)
NT3	15t/ha (6.75 + 50% NPK 15:15:15)
NT4	10t/ha (4.5kg + 50% 15:15:15)
NT5	(100% NPK 15:15:15)
NT6	Control

Note: T1 = Tilled, NT = not tilled, NPK = Nitrogen, Phosphorus and Potassium.
t/ha = ton per hectare.
5t/ha= 2.25kg (50i:50o).
10t/ha=4.5kg (100%o).
10t/ha=4.5kg (50i:50o).
15t/ha=6.75kg (50i:50o).
i=inorganic, o=organic.

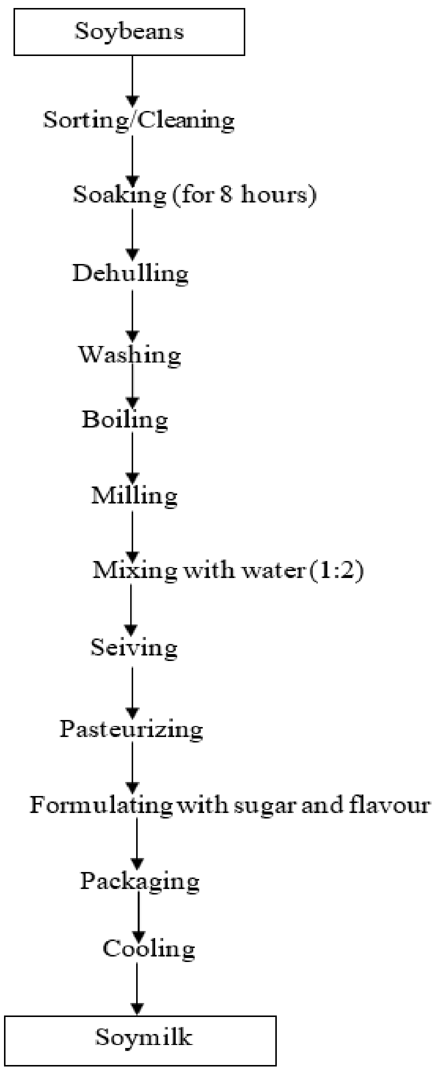

Figure 1. Production of soymilk.

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2.4. Functional Properties Determination

Bulk density and water absorption capacity were determined by the method described by Okaka and Potter (1979); while Swelling index and foaming capacity were determined using the method described by Onwuka (2005).

2.5. pH Determination

The pH of the samples was determined using the method of AOAC (2010).

2.6. Determination of Proximate Composition

The moisture, protein, fat, fibre and ash contents of the soybean samples and control were determined by AOAC (2010). The carbohydrate content of the samples was determined by difference: % carbohydrate = 100 – (% moisture + protein + % ash + crude fibre + fat).

2.7. Determination of Micronutrients

Iron was determined following the phenanthroline method of Lee and Stumm (1960). Potassium was determined by a procedure described by Osborne and Voogt (1978) using a flame photometer whilecalcium was determined using the method described by Peason (1976). Vitamin B1 content was determined using the scalar analyzer method of AOAC (2010). Vitamins B2 and B6 and B12 were also determined by the AOAC (2010).

2.8. Determination of Antinutrients

Phytate content was determined using spectrophotometric method as described by Peason (1976). Trypsin inhibitor was determined using the method described by Kakade, Rackis, McGhee, and Puski (1974) while Haemagglutinins was determined by the spectrophotometric method of AOAC (2010).

2.9. Sensory Evaluation

The soymilk samples were evaluated organoleptically using twenty panel members who were familiar with quality attributes of soymilk. The samples were coded and presented in identical containers. A 9-point hedonic scale was used to evaluate the soymilk for colour, taste, mouth feel and general acceptability as described by Ihekoronye and Ngoddy (1985). The scale ranged from like extremely (9) to dislike extremely (1). Sample presentation to the panelists was carried out randomly one at a time and also not more than five panelists were invited in the sensory evaluation area at a time. Each judge was offered a sachet of water to rinse the mouth between samples.

2.10. Experimental Design and Statistical Analysis

The experimental design was laid out in a completely randomized design (CRD). Data obtained from the analysis was analyzed statistically using one-way analysis of variance (ANOVA). Means was separated by Duncan's multiple range test method and the level of significance was accepted at ($p < 0.05$) according to Steel and Torrie (1980).

3. RESULTS AND DISCUSSION

3.1. Functional Properties of Soybean Flour Samples

The functional properties results of the soybean flour samples are shown in Table 2. The bulk density of the sample ranged from (0.54 to 0.69g/cm^{3}). The samples from tilled soil had no significant ($p>0.05$) differences, and had higher bulk densities than samples from non- tilled soil; except for sample T5 with 100% fertilizer treatment. This sample compared favourably with samples from non-tilled soil. Bulk density is usually affected by particle size and density of flour and it is very essential in evaluating the packaging requirement, material handling and application in wet processing in the food industry (Ajanaku, Ajanaku, Edobor-Osoh, & Nwinyi, 2012). Eshun (2012),

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reported bulk density values which ranged from 1.56 g/cm³ to 2.09 g/cm3 in some varieties of soybean. These values were higher than those obtained in the study. High bulk density is generally desirable for the ease of dispersibility and reduction of paste thickness which is an important factor in child feeding (Sengev, Akpapunam, & Ingbian, 2012).

The pH of the sample ranged from 6.20 to 6.40. There was no significant ($p>0.05$) difference between sample T_1 to T_5 and NT_3 to NT_4. There was significant difference ($p<0.05$) among the sample in their pH level. This shows that the soil treatments did not have any effect on the soybean samples.

The swelling capacity of the soybean flour sample as shown in Table 2 ranged from 87.44 ml/g to 248.75ml/g with sample NT_6 having the lowest value while sample T_2 had the highest value 248.75mg/100g. There was significant ($p<0.05$) difference among the samples. The treatments affected the samples as compared with the control. Samples from tilled soil generally had higher values for swelling capacity. The values obtained were slightly higher than the value reported by Emmanuel, Therese, Mdziniso, and Bussie (2017).

The values obtained for water absorption capacity (WAC) of the samples ranged from 0.65 to 1.45ml/g. The treatments given to samples significantly ($p<0.05$) affected the samples. The soybean samples from tilled soil had higher WAC when compared with the corresponding samples from non-tilled samples; except for the samples from 100% inorganic treatment and the control samples. Sample NT_4 had the lowest value while sample T_3 had the highest value. There was no significant ($p>0.05$) difference between sample T_1, T_5, T_6 and NT_2 as shown in Table 2. Water absorption capacity of flour generally depends on starch, protein content and particles size, as reported by Awuchi, Igwe, and Echeta (2019). The results obtained for foaming capacity of the soybean flour samples ranged from 5.45 to 31.7%. These results were significantly ($p<0.05$) affected by the different treatments given to the soil samples. The highest value was obtained from sample NT_4, which is a sample from non-tilled soil treated with 50% combination each of organic and inorganic fertilizers.

Table 2. Functional properties of soybean samples from various soil treatments.

Samples	Bulk Density (g/cm³)	pH	Swelling Capacity (%)	Water Absorption Capacity (g/ml)	Foaming Capacity (%)
T1	$0.69^{c}\pm0.01$	$6.30^{bc}\pm0.14$	$197^{g}\pm12.17$	$0.92^{d}\pm0.01$	$11.56^{f}\pm0.21$
T2	$0.67^{bc}\pm0.00$	$6.30^{bc}\pm0.07$	$248^{h}\pm3.68$	$0.91^{d}\pm0.02$	$15.85^{e}\pm0.07$
T3	$0.66^{bc}\pm0.00$	$6.30^{bc}\pm0.07$	$157^{e}\pm4.29$	$1.45^{h}\pm0.01$	$22.25^{g}\pm0.00$
T4	$0.67^{bc}\pm0.00$	$6.30^{bc}\pm0.14$	$137^{d}\pm1.10$	$1.05^{e}\pm0.01$	$7.90^{b}\pm0.21$
T5	$0.56^{a}\pm0.01$	$6.20^{bc}\pm0.07$	$113^{bc}\pm3.23$	$0.79^{c}\pm0.01$	$5.45^{a}\pm0.14$
T6	$0.62^{b}\pm0.00$	$6.40^{c}\pm0.07$	$105^{b}\pm2.52$	$0.79^{c}\pm0.01$	$13.5^{d}\pm0.40$
NT1	$0.63^{bc}\pm0.04$	$6.10^{ab}\pm0.14$	$175^{f}\pm3.49$	$0.79^{c}\pm0.01$	$7.50^{d}\pm0.14$
NT2	$0.60^{ab}\pm0.01$	$5.90^{a}\pm0.07$	$138^{d}\pm1.99$	$0.73^{b}\pm0.02$	$23.50^{h}\pm0.21$
NT3	$0.54^{a}\pm0.05$	$6.20^{bc}\pm0.07$	$103^{d}\pm2.89$	$1.37^{g}\pm0.14$	$7.75^{d}\pm1.41$
NT4	$0.63^{bc}\pm0.01$	$6.30^{bc}\pm0.07$	$102^{b}\pm1.49$	$0.65^{a}\pm0.12$	$31.70^{i}\pm0.28$
NT5	$0.55^{a}\pm0.07$	$6.40^{c}\pm0.06$	$117^{c}\pm3.19$	$1.40^{h}\pm0.01$	$10.20^{c}\pm0.21$
NT6	$0.59^{ab}\pm0.01$	$6.30^{bc}\pm0.00$	$87^{a}\pm7.29$	$1.15^{f}\pm0.01$	$11.05^{c}\pm0.21$

Note: Values are means of duplicate determinations ± SD. Means in the same column with different superscripts are significantly ($p< 0.05$) different.

3.2. Proximate Composition of Soybean Samples from Various Soil Treatments

The results of the proximate composition of the soybean flour samples are shown in Table 3. The moisture content of the samples ranged from 6.41 to 8.17%. Sample T_2 had the lowest moisture content while sample T_5 had the highest moisture content. There was no significant ($p>0.05$) difference between the samples. The moisture content observed in the samples may be an advantage in prolonging the shelf life of the products, if properly packaged. The values obtained are in range with the value (6.13%) recorded by Emmanuel et al. (2017).

Protein content of the samples ranged from 29.05 to 49.65%. The samples were significantly ($p<0.05$) different from each other. Samples from tilled soil showed higher protein levels when compared to their corresponding samples from non-tilled soil. However, sample from 100% inorganic treatment (T_5) had the highest protein content,

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probably because of higher Nitrogen presence in the treatment. Sample NT2 had the lowest protein content. The values obtained were in range with (36.56) as reported by Emmanuel et al. (2017).

The Fat content of the soybean flour samples ranged from (15.09 to 18.65%). Sample NT_4 had the lowest value and sample T_2 had the highest value. The value obtained was slightly lower than 19.82 reported by Emmanuel et al. (2017).

The Ash content of the samples ranged from 4.69 to 8.22%. There was significant ($p<0.05$) difference between the samples. Sample NT_3 had the lowest value 4.69% while sample T_2 had the highest value (8.22%). The samples from tilled soil were generally higher in ash content; also the samples from 100% organic fertilizer showed higher ash values than those from inorganic fertilizer. Ash content is an index of mineral content of food materials which are needed for growth and development.

The results of the Fibre content of the soybean flour samples ranged from 5.05 to 13.73%. There was significant ($p<0.05$) difference among the sample. Sample T_3 had the lowest value (5.05%) while sample NT_5 had the highest values (13.73%).

The obtained carbohydrate values ranged from 19.95 to 32.40% with sample T_2 having the lowest value (19.95%) while sample NT_6 had the highest values (32.40%). This high value observed in NT_6 is an indication that the other proximate components were low in soybean samples from non-tilled soil.

Table 3. Proximate composition of soybean samples from various soil treatments.

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrate (%)
T1	$6.51^{a}\pm 0.03$	$38.6^{h}\pm0.42$	$16.28^{c}\pm0.06$	$4.74^{a}\pm.21$	$7.02^{b}\pm0.00$	$26.85^{bcd}\pm0.31$
T2	$6.41^{a}\pm0.04$	$34.20^{e}\pm0.42$	$18.65^{g}\pm0.08$	$8.22^{b}\pm1.46$	$12.57^{i}\pm0.02$	$19.95^{a}\pm0.97$
T3	$7.15^{b}\pm0.14$	$36.40^{g}\pm0.42$	$17.18^{de}\pm0.03$	$6.17^{ab}\pm1.59$	$12.22^{h}\pm0.00$	$26.89^{bcd}\pm0.99$
T4	$6.32^{a}\pm0.04$	$40.75^{i}\pm0.49$	$16.95^{de}\pm0.04$	$5.91^{ab}\pm1.60$	$5.05^{a}\pm0.04$	$25.02^{bc}\pm1.07$
T5	$8.17^{e}\pm0.11$	$49.65^{j}\pm0.35$	$17.34^{de}\pm0.78$	$5.99^{ab}\pm1.54$	$13.01^{j}\pm0.01$	$20.28^{a}\pm0.16$
T6	$7.76^{d}\pm0.03$	$30.80^{c}\pm0.28$	$16.75^{cd}\pm0.06$	$6.36^{ab}\pm1.66$	$8.12^{c}\pm0.00$	$30.22^{ef}\pm1.29$
NT1	$6.96^{c}\pm0.18$	$34.20^{e}\pm0.42$	$15.74^{b}\pm0.05$	$5.07^{a}\pm0.09$	$9.95^{e}\pm0.04$	$28.08^{cde}\pm0.45$
NT2	$7.33^{b}\pm0.01$	$29.05^{b}\pm0.07$	$18.29^{g}\pm0.02$	$4.84^{a}\pm0.07$	$11.36^{f}\pm0.01$	$25.12^{b}\pm0.01$
NT3	$7.32^{b}\pm2.86$	$32.00^{d}\pm0.42$	$15.73^{b}\pm0.07$	$4.69^{a}\pm0.04$	$12.24^{h}\pm0.00$	$28.02^{cde}\pm3.27$
NT4	$6.66^{a}\pm0.03$	$34.20^{e}\pm0.42$	$15.09^{a}\pm0.04$	$4.91^{a}\pm0.04$	$9.44^{d}\pm0.02$	$29.71^{def}\pm0.46$
NT5	$6.61^{a}\pm0.09$	$45.15^{f}\pm0.49$	$17.75^{f}\pm0.06$	$5.51^{a}\pm0.72$	$13.73^{k}\pm0.01$	$21.26^{a}\pm1.39$
NT6	$7.19^{b}\pm0.21$	$26.45^{a}\pm0.35$	$17.08^{de}\pm0.03$	$4.86^{a}\pm0.10$	$12.02^{g}\pm0.04$	$32.40^{f}\pm0.72$

Note: Values are means of duplicate determinations ± SD. Means in the same column with different superscripts are significantly ($p< 0.05$) different.

3.3. Micronutrient Content of Soybean Samples from Various Soil Treatments

Table 4 shows the results of micronutrient (vitamins B_1, B_2, B_{12}, B_6 and calcium) contents of the soy bean flour samples. Vitamin B_1 content of the samples ranged from 2.11 to 2.52mg/100g. Sample T_1 had the highest values (2.52mg/100g) while sample NT_5 had the lowest values. There was significant ($p<0.05$) difference among the samples. Vitamin B_2 ranged from 0.18 to 0.39mg/100g. Sample NT_1 had the highest vitamin B_2 content while sample NT_3 had the lowest values. There was significant ($p< 0.05$) difference among the sample. The values obtained ranged from 0.01to 0.03mg/100g. The values obtained shows that the samples were low in vitamin B_{12} content. There was significant ($p< 0.05$) difference among the samples. The values for vitamin B_6 obtained ranged from 9.80 to 14.73mg/100g. Sample T_2 had the lowest values while sample NT_4 had the highest values. Soybean samples from non-tilled soil were generally higher than samples from tilled soil. This is probably as a result of increase organic matter which is synonymous with non-tilled fields. The result of calcium content as shown in Table 4 ranged from 26.25 to 49.52mg/100g with sample NT_3 having the highest value and sample NT_2 had the lowest value 26.25mg/100g. There was significant ($p<0.05$) difference among the samples.

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Table 4. Micronutrient composition of the soybean samples from various soil treatments.

Samples	Vitamin. B1 mg/100g	Vitamin. B2 mg/100g	Vitamin. B12 mg/100g	Vitamin.B6 mg/100g	Calcium (mg100g)
T1	$2.52^{i}\pm0.03$	$0.33^{f}\pm0.00$	$0.02^{a}\pm0.00$	$12.19^{c}\pm0.04$	$34.90^{b}\pm 0.06$
T2	$1.28^{b}\pm0.0$	$0.20^{b}\pm0.1$	$0.01^{b}\pm0.0$	$9.80^{b}\pm0.03$	$37.49^{d}\pm 0.01$
T3	$1.19^{a}\pm0.00$	$0.27^{d}\pm0.00$	$0.02^{a}\pm0.00$	$11.25^{c}\pm0.03$	$32.51^{db}\pm 0.01$
T4	$1.21^{a}\pm0.0$	$0.27^{d}\pm0.00$	$0.02^{a}\pm0.0$	$9.57^{a}\pm0.04$	$37.49^{d}\pm 0.03$
T5	$1.85^{g}\pm0.00$	$0.18^{a}\pm0.00$	$0.03^{c}\pm0.01$	$11.29^{c}\pm0.01$	$32.30^{b}\pm 0.28$
T6	$1.59^{e}\pm0.03$	$0.36^{h}\pm0.00$	$0.02^{a}\pm0.01$	$13.41^{g}\pm0.04$	$32.30^{b}\pm 0.28$
NT1	$1.19^{a}\pm0.00$	$0.39^{i}\pm0.00$	$0.02^{a}\pm0.01$	$11.63^{d}\pm0.01$	$43.75^{f}\pm1.77$
NT2	$1.18^{a}\pm0.00$	$0.28^{e}\pm0.01$	$0.02^{a}\pm0.02$	$13.29^{f}\pm0.06$	$26.25^{a}\pm1.77$
NT3	$1.44^{b}\pm0.00$	$0.24^{c}\pm0.00$	$0.01^{a}\pm0.02$	$14.60^{h}\pm0.02$	$49.52^{h}\pm0.68$
NT4	$1.71^{f}\pm0.01$	$0.34^{g}\pm0.00$	$0.02^{a}\pm0.01$	$14.13^{a}\pm0.04$	$37.51^{d}\pm 0.01$
NT5	$2.11^{h}\pm0.01$	$0.35^{g}\pm0.00$	$0.01^{b}\pm0.00$	$14.63^{h}\pm0.02$	$40.02^{e}\pm 0.02$
NT6	$1.35^{c}\pm0.00$	$0.33^{f}\pm0.00$	$0.02^{a}\pm0.00$	$13.47^{g}\pm0.04$	$47.48^{g}\pm 0.04$

Note: Values are means of duplicate determinations ± SD. Means in the same column with different superscripts are significantly ($p< 0.05$) different.

3.4. Antinutrient Content of Soybean Samples from Various Soil Treatments

Table 5 shows the antinutrient content of the soybean samples from various soil treatments. The phytate content ranged from 0.11 to 0.20 mg/100g. There were significant ($p<0.05$) differences among the samples. Sample T_5 had the lowest value while NT_2 had the highest value. Phytic acid, a hexaphosphate derivative of inositol is an important storage form of phosphorus in plant. It forms complexes with mineral elements such as calcium, iron and zinc and hinders their absorption and bioavailability (Bohn, Davidsson, Walczyk, & Hurrell, 2004).

Results of trypsin inhibitor obtained for the samples ranged from 0.05 to 0.017mg/100g with sample T_1 having the lowest value and sample NT_3 had the highest value. There was significant ($p<0.05$) difference among the samples. Trypsin inhibitors are kunitz factor and bowman- Birk factor found in raw soybeans that inhibit protease enzymes in the digestive tract.

Table 5. Antinutrient content of the soybean samples from various soil treatments.

Samples	Phytate mg/100g)	Trypsin Inhibitor (mg/100g)	Heamaglutinin (Hu/gm)
T1	$0.17^{cde}\pm0.03$	$0.05^{ab}\pm0.01$	$0.74^{ab}\pm0.02$
T2	$0.13^{ab}\pm0.01$	$0.11^{bcd}\pm0.02$	$0.95^{abcd}\pm0.76$
T3	$0.14^{abc}\pm0.00$	$0.12^{cde}\pm0.04$	$0.78^{ab}\pm0.01$
T4	$0.15^{abcd}\pm0.02$	$0.13^{cde}\pm0.01$	$0.56^{a}\pm0.05$
T5	$0.11^{a}\pm0.02$	$0.07^{abc}\pm0.01$	$0.72^{ab}\pm0.01$
T6	$0.19^{cde}\pm0.01$	$0.11^{bcd}\pm0.01$	$0.92^{abcd}\pm0.01$
NT1	$0.13^{ab}\pm0.01$	$0.16^{de}\pm0.04$	$1.01^{abcd}\pm0.02$
NT2	$0.20^{de}\pm0.00$	$0.06^{ab}\pm0.01$	$0.91^{abcd}\pm0.01$
NT3	$0.15^{abcd}\pm0.03$	$0.17^{de}\pm0.02$	$1.44^{d}\pm0.04$
NT4	$0.12^{bcd}\pm0.01$	$0.05^{ab}\pm 0.02$	$1.15^{bcd}\pm0.02$
NT5	$0.12^{ab}\pm0.01$	$0.16^{de}\pm0.01$	$0.88^{abc}\pm0.02$
NT6	$0.14^{abc}\pm0.00$	$0.13^{cde}\pm 0.03$	$1.36^{cd}\pm0.01$

Note: Values are means of duplicate determinations ± SD. Means in the same column with different superscripts are significantly ($p< 0.05$) different.

The result of hemagglutinin content of the samples ranged from 0.56 to 1.44 Hu/gm. Most of the samples showed no significant ($p>0.05$) difference. This implies that they were rarely affected by the soil treatments. NT_3 had the highest value while T_4 had the lowest value. Hemagglutinins, also called lectins, are all proteins and are found majorly in legumes. Hemagglutinins in raw legumes are significant because they are found in higher concentration than in other sources. Crude raw extract of hemagglutinin agglutinates the red blood cells of human beings and other animals if injected directly into the blood stream.

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Thus, it impairs the utilization of legumes such as beans, groundnut, cowpeas black beans, pigeon peas among others, especially when they are not properly processed for human or animal consumption. Detoxification of hemagglutinins is usually achieved by the traditional methods of house hold cooking and industrial autoclaving or retorting (Enwere, 1998).

3.5. Sensory Scores of Soymilk Samples from Various Soil Treatments

The results of sensory analysis of the soymilk samples as presented in Table 6 ranged from 6.78 to 7.65 for colour. Sample T_2 had the highest value while sample T_6 had the lowest values. Sample T_2 had the most accepted colour, though there was no significant ($p>0.05$) difference among the samples.

The sensory rating for flavor shows that sample T_5 was better accepted in terms of flavor as compare to others. The values obtained ranged from 5.20 to 7.20. All the samples showed no significance ($p>0.05$) difference, except sample T_6, which is the control sample. The result for taste ranged from 5.10 to 7.25. Sample T_5 was better accepted when compared to others. Sample T_6 was least accepted in terms of taste. There was significant ($p<0.05$) difference among the samples. The control samples had the best taste and showed no significance ($p>0.05$) difference. The result of aroma ranged from 6.05 to 7.50. There was significant ($p<0.05$) difference among the samples. The result of mouth feel ranged from 5.55 to 7.05. Sample NT_2 had the highest value while sample T_6 has the lowest value (5.55). There was significant ($p<0.05$) difference among the samples. Overall Acceptability showed that sample T_5 had the highest value while sample T_6 had the lowest value. The difference may be due to the various treatments given to the sample. There was significant difference ($p<0.05$) among the samples.

Table 6. Sensory scores of the soymilk samples from various soil treatments.

Samples	Colour	Flavour	Taste	Aroma	Mouthfeel	Overall Acceptability
T1	7.50^{a} ±0.69	6.90^{b} ±1.74	6.65^{bc} ±1.93	6.95^{b} ±1.42	6.95^{b} ±1.50	6.90^{b} ±1.45
T2	7.65^{a} ±0.81	6.95^{b} ±1.28	6.40^{bc} ±1.39	6.75^{ab} ±1.21	6. 70^{b} ±1. 38	6.95^{b} ±1.05
T3	7.10^{a} ±I.33	6.55^{b} ±I.64	6.00^{ab} ±1.37	6.65^{ab} ±1.39	6.40^{ab} ±1.79	6.50^{b} ±1.57
T4	7.00^{a} ±0.99	6.25^{b} ±1.16	5.95^{ab} ±1.15	6.55^{ab} ±0.99	6.40^{ab} ±1.14	6.30^{ab} ±1.08
T5	7.15^{a} ±1.27	7.20^{b} ±1.36	7.25^{c} ±1.07	6.85^{ab} ±1.27	7.05^{b} ±1.32	7.35^{b} ±1.39
T6	6.75^{a} ±2.02	5.20^{a} ±1.88	5.10^{a} ±2.13	6.05^{a} ±1.70	5.55^{b} ±2.39	5.45^{a} ±2.37
NT1	7.20^{a} ±1.15	6.50^{b}±1.32	6.65^{bc}±1.42	66.5^{ab} ±1.31	7.00^{b} ±1.17	6.80^{b} ±1.39
NT2	6.80^{a} ±1.80	6.50^{b} ±I.61	6.55^{bc} ±1.50	6.75^{ab} ±0.91	6.45^{ba} ±1.39	6.40^{ab} ±1.82
NT3	7.20^{a} ±1.24	6.45^{b} ±1.15	6.30^{bc} ±1.30	6.30^{a} ±1.45	6.30^{ab}±1.38	6.35^{ab} ±1.27
NT4	6.80^{a} ±1.07	6.2d5^{b} ±1.21	6.20^{bc} ±1.44	6.30^{a} ±1.45	7.05^{b} ±1.54	6.55^{b} ±1.39
NT5	7.50^{a} ±1.05	6.75^{b} ±1.48	7.15^{c} ±1.53	7.50^{b} ±0.95	7.05^{b} ±1.47	7.35^{b} ±1.35
NT6	7.00^{a} ±1.52	6.55^{b} ±1.50	6.75^{bc} ±1.77	6.65^{ab} ±1.63	6.45^{ab} ±1.76	6.75^{b} ±1.52

Note: Values are means of 20 panelists ± SD. Means in the same column with different superscripts are significantly ($p< 0.05$) different.

4. CONCLUSION

This study has shown that functional and chemical composition of soybean can be affected by various soil treatments. This is evidenced by the results which significantly varied from the control samples. Samples from tilled soil showed higher values for swelling and foaming capacity. Protein and ash content values were also higher in samples from tilled soils. Soybean samples from 100% inorganic treated soil had higher protein values than those from 100% organic fertilizer treatment. However, a reverse trend was observed in the micronutrient values of the samples. The values were higher in samples from 100% organically treated soil, especially with the tilled soil. All the soymilk samples had high organoleptic ratings, however, best results were observed in samples from tilled, 100% inorganic treatment.

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Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study.

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