Original Research Article

Effect of bio-slurry fertiliser on the nutritional quality of shade net grown Swiss chard

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ABSTRACT

This study aimed to evaluate the type of bio-slurry fertiliser produced from various feedstock sources that could improve the nutritional properties of shade net-grown Swiss chard.

The experiment was conducted in a randomised complete block design in a factorial arrangement with three replications at Pwani University's integrated biogas Unit. The factors studied were; a) Covers (shade net and open) and the second factor was bio-slurry fertiliser treatments (T1 = No fertiliser, T2 = 100 % DAP+100 %CAN, T3 =100 % Kitchen bio-slurry fertiliser, T4 = 100 % Cow dung bio-slurry fertiliser, T5 = 50 % DAP -18:46:0 + 50 % CAN + 50 % kitchen bio-slurry fertiliser, T6 = 50 % DAP- -18:46:0- + 50 % CAN + 50 % cow dung bio-slurry fertiliser, T7 = 50 % kitchen bio-slurry fertiliser + 50 % cow dung bio-slurry fertiliser).Data were analysed using ANOVA at a 5% significance level. The results indicated that bio-slurry treatments significantlyinfluenced moisture, protein, fat, ash, carbohydrates, flavonoids, tannin, oxalates, carotenoids, chlorophyll and phytates compared with the control where no fertiliser was applied. It was also noted that bio-slurry treatment significantly influenced phosphorus, potassium, calcium, magnesium, iron, zinc and sodium compared with the control. The study concluded that a combination of 50%kitchen waste bio-slurry and 50% cow dung bio-slurry improves the nutritional quality of Swiss chard.

Keywords: Bio-digester feedstock, Bio-slurry, Experimental unit, Inorganic fertiliser

1. INTRODUCTION

Assimilates are the measurable basis of production and nutritional quality of a crop. The elements for promoting crop production and increasing can improve crop nutritional quality [26]. Bio-slurry is endowed with amino acids, humus, organic molecules and bioactive constituents needed for crop growth and development; these can promote plant growth and nutrient absorption and significantly improve crop quality [26; 10]. A study conducted by [59] revealed that the use of bio-slurry could significantly improve protein and minerals in rice. The use of bio-slurry fertiliser could influence the cabbage's nutritional quality and total sugar, reducing sugar, amino acid and vitamin C, while nitrate concentration is reduced [60]. Kilifi County in Kenya is facing micronutrient deficiency problems and associated chronic diseases [16]. Production of Swiss chard (*Beta vulgaris*) should be promoted since it is a tremendous source of nutrients and several phytochemicals and, at the same time, an

inexpensive food crop [49]. Swiss chard (*Beta vulgaris*) is a leafy vegetable widely consumed in various parts of the world. Farmers prefer Swiss chard to spinach and celery since it is more robust and easier to produce [45]. The leaves and the stalks of Swiss chard are nutritious, with a high content of vitamins (A, K and C), minerals such as potassium, calcium, magnesium, iron and phosphorus), fibre and proteins [50]. Based on the USDA National Nutrient Database (2014), compared to green lettuce, Swiss chard contains significantly higher values of minerals, apart from Ca, K, Fe, Mn, Zn and proteins than spinach. The key well-known secondary metabolites are flavonoids, flavonoid glycosides and saponins [41]. Contemporary pharmacologists reported the significance of bioactive molecules from Swiss chard extracts and revealed their anti-diabetic, anti-inflammatory, antioxidant and anticancer role [5]. However, several studies in many geographical areas, including Kilifi County, concentrated on assessing the effect of animal dung bio-slurry as organic fertilisers on growth and yield. Very few studies are available on the effect of bio-slurry feedstock fertilisation on the nutritional quality of Swiss chard grown under shade net. Therefore, the objective of this study was to find out the type of feedstock source that could improve the nutritional properties of shade net-grown Swiss chard.

2. MATERIAL AND METHODS

2.1 Study site

The study was carried out during the 2021/2022 and 2022/2023 growing seasons at Pwani University (PU) Integrated biogas research unit located at 39^{o}44'East and 3^{o} 50'South and at an altitude of 30m above mean sea level, which lies in the coastal belt of Kenya, 60 km north of Mombasa [49]. The region receives low, bimodal rainfall ranging from 600-1000 mm annually. With the long rain, the more dependable season occurs from March to June. The temperature in the region ranges from 23 ^{o}C to 30 ^{o}C respectively, and the average relative humidity of 80%. The soils are predominantly sandy loam [39]

2.2 Experimental materials

2.2.1 Swiss chard seed

Swiss chard is a leafy vegetable which is extensively cultivated, and due to its early maturity, it is an excellent food security crop [32]. In addition, it acts as a source of income in Kenya. There is a high demand for Swiss chard in Kilifi County. However, it is not commonly grown in Kilifi, and therefore, there is a need to demonstrate its suitability in terms of its performance under the prevailing shade net conditions. The variety that was used for the experiment was a giant Ford hook that was sourced from Kilifi Agro vet shops. The giant ford hook is a green leafy plant with a white stalk [25]

2.2.2 Feed materials

The source feed stock used for this study include;

2.2.2.1 Kitchen waste

Kitchen wastes were left over from the student-catering unit as well asfrom Universitystaff quarters, which were both pre-cooked and cooked foodstuff. These pre-cooked and cooked waste include; uncooked cabbage, uncooked kales, uncooked tomatoes, potato peels, cooked potatoes, tarmarine, cooked bones with flesh, sieved tea leaves, cooked beans cooked rice and 50 % of this waste contained cooked Ugali and rice waste. Kitchen waste bio-slurry is rich in nitrogen and potassium [46].

Table 1: Chemical composition of kitchen waste

Parameters	Weight fraction (%) or ratio
Total solids	14.8
Total volatile solids	89.5
Ash	10.5
Total organic carbon	47.7
Kjeldahl nitrogen	1.3
C/N weight ratio	38.2
Fat	8.7
Protein	6.7
Cellulose	14.9
Hemi-cellulose	9.9
Lignin	8.5
Moisture contents	84.5

Source: Warnars and Oppenoorth, 2014

2.2.2.2 Cow dung

Cow dung is undigested remains of consumed feed material defecated by cattle. It is composed of faeces and urine in a ratio of 3:1. It consists mainly of lignin, cellulose and hemicelluloses. It also has 24 minerals such as nitrogen, potassium and trace elements like Sulphur, iron, magnesium, copper, cobalt and manganese. Cow dung contains different species of bacteria, protozoa and yeast [46]. Cow dung was collected as fresh from the Pwani University dairy unit, where the cows feed on grass material and other leafy plants under a free-range grazing system.

Table 2: Chemical composition of cow dung manure

Parameters	Dry matter as % of fresh manure	Dry matter (%)	Organic material (%)	Total nitrogen (%)	Total phosphorus (%)	Total potassium (%)
Weight fraction(%)	10-15	10-15	14.4	0.30-0.45	0.15-0.25	0.05-0.15

Source: Randhawa and Kullar, 2011

2.2.2. 3 Flexi biogas system

The Flexi biogas system was used to digest the materials **(**Figure 2). Flexi biogas digester is moveable and elastic. It consists of a flexible digester bag, which is housed in a fabric tunnel. The tunnel serves as an insulator, which absorbs heat and maintains the temperature between 25 °C and 36 °C. The tunnel and the elastic bag increase the volume of gas production and decrease the retention time, ensuring a faster rate of fermentation and gas release. It is then piped via PVC pipe connected to a stove for cooking. The flexi biogas

digester does not require an agitator, and it is simply a 6 m x 3 m envelope made of PVC canvas and housed in a fabric tunnel. It is simple and easy to operate [47]**.**

Figure 2. Flexi biodigester

2.2.2.4 Shade net

The shade net used was black, with a light intensity of 55 % and a relative humidity capacity of 24%. Its dimensions were 20m long, 8m wide, and 8 m in height, which was sourced from Amiran Kenya in Nairobi.

Figure 3. Swiss chard under shade net

2.2.2.5 Plant material (Cultivar selection)

One cultivar of Swiss chard 'Ford-Hook giant' is commonly consumed in Kilifi County. Swiss chard-certified seeds were sourced from an agro-vet shop. Green leaves and a white stalk characterize the 'Ford-Hook giant'.

2.2.2.6 Organic shredder

The Organic Shredder is a powerful shredder, which is 1.5 HP, which rapidly and simply handles kitchen waste. The shredder has a hopper with a protective bar and a specific opening. In addition, it has a pair of wheels and a handle, which make it portable and navigable. The shredder is easy to use. It is simply turned on with a quick switch, and in a moment, the waste is turned into organic chips.

2.2.2.7 Fertilisers

The inorganic fertilisers used in the experiment include di-ammonium phosphate (18% N: 46% P_2O_5:0% K_2O) and calcium ammonium nitrate (CAN; 26% N). The DAP was applied to the respective treatments at planting, and CAN was applied as a top dressfour weeks after transplanting. While the organic fertiliser used include bio-slurry fertiliser from the kitchen source feedstock and that from cow dung. Other materials used include a jembe, tape measure, pesticides (belt, carbendazim), a 30 cm ruler, a 1-meter ruler, and a pen.

2.3 Treatment application

The bio-slurry fertiliser was collected from two bio-digesters from Pwani University Integrated Biogas Unit. One digester was fed with kitchen feedstock, and the second digester was fed with cow dung. Before feeding the kitchen feedstock, it was shredded to increase surface area. Before application, bio-slurry was mixed with water at the ratio of 1:1. Bio-slurry fertilizer treatments used were; T1 = No fertiliser, T2 = 100 % DAP+100 %CAN, T3 =100 % Kitchen bio-slurry fertiliser, T4 = 100 % Cow dung bio-slurry fertiliser, T5 = 50 % DAP (18:46:0) + 50 % CAN + 50 % kitchen bio-slurry fertiliser, T6 = 50 % DAP (18:46:0) + 50 % CAN + 50 % cow dung bio-slurry fertiliser, T7 = 50 % kitchen bio-slurry fertiliser + 50 % cow dung bio-slurry fertiliser.

2.4 Experimental design

A randomisedcomplete block design (RCBD) in factorial treatment arrangement was used and replicated three times (list1). The factors studied were covered at two levels (shade net or open) and bio-slurry treatments at seven levels, as indicated. The size of each experimental unit was 2.1 m x 1.9 m. The total experimental field measured (19.7 m x 2.1m) = 127.14 m^2. Plots had a path of 0.5 m between them and 0.5 m between the replications. Seedlings were transplanted at a spacing of 45 cm x 30 cm. The experiment was set both in the open field (control) and under the shade net

	SHADE NET			OPEN FIELD		
Key	**Block 1**	**Block 2**	**Block 3**	**Block 1**	**Block 2**	**Block 3**
T1 = Control (No fertilizer Applied)	**T6**	**T3**	**T3**	**T1**	**T6**	**T4**
T2 = 100 % DAP+100 %CAN	**T4**	**T2**	**T2**	**T5**	**T7**	**T5**
T3 =100 % Kitchen bio-slurry	**T7**	**T5**	**T1**	**T6**	**T1**	**T3**
T4 = 100 % Cow dung bio-slurry	**T5**	**T6**	**T6**	**T7**	**T4**	**T7**
T5 = 50 % DAP (18:46:0) + 50 % CAN + 50 % kitchen bio-slurry	**T1**	**T1**	**T4**	**T2**	**T2**	**T6**
T6 = 50 % DAP (18:46:0) + 50 % CAN + 50 % cow dung bio-slurry	**T2**	**T7**	**T5**	**T3**	**T5**	**T2**
T7 = 50 % kitchen bio-slurry + 50 % cow dung bio-slurry	**T3**	**T4**	**T7**	**T4**	**T3**	**T1**

List1. Experimental layout

2.5 Data collection

2.5.1 Soil analysis

The soil was sampled at a depth of 0-30 cm at four points for each diagonal and was mixed thoroughly for the entire plot before the cropping season to make a composite and for each experimental unit after the cropping season. The soil samples, each weighing 500 grams, were taken to Agro Care for the physical and chemical composition of the soil.

Bulk density was calculated as the dry weight of soil divided by its volume. This volume included the volume of soil particles and the volume of pores among soil particles. Bulk density was expressed in g/cm^3 [38]. While total porosity was determined from bulk density and particle density values calculation [38].

To determine the nutrients level the soil samples were analysed using standard laboratory analysis method (APHA, AWWA, and WPCF2005). The pH levels was determined using pH meter (Hanna EC/PH meter). Soil pH was measured in 1:2.5 dilution. Extractable phosphorus (P_20_5) was determined as per the Bray method as recorded by [3]. Total

nitrogen (N %) was determined by Kjeldahl and Na, K and Ca was determined using standard method as recorded by [31]. Determination of CEC was done after washing the samples with alcohol using ammonium acetate method while electrical conductivity (EC) as reported by [34].

Soil moisture content was determined using a method as recorded by (7)

2.5.2 Bio-slurry and tissue analysis

Leaf tissue from each treatment was freeze-dried using liquid nitrogen, and 400 grams of freeze-dried leaves and five hundred millilitres of the cow dung bio-slurry fertiliser and kitchen waste bio-slurry fertiliser were sampled and taken for laboratory analysis [13] to Agro Care (Nairobi, Kenya) to determine the chemical composition,proximate composition, gross energy contents and mineral.

For nutrient determination, rapid chemical tissue analysis methods was used as noted by (42).Sodium and potassium was analysed as recorded by [61]. Amount of carotenoids and chlorophyll was determined [9].Tannins was determined as described by [36] where 1 ml of methanolic extract was added to 5 ml of vanillin substance and the mixture incubated for half an hour at ambient temperature. Then, the absorbance was recorded at 500 nm using a spectrophotometer. The concentration of tannins in the samples was determined using a calibration curve of tannic acid (2 mg/mL).The total flavonoids concentration was determined as described by [8]by mixing 0.5 ml of the methanolic extract with 0.5 ml methanol, 0.5 ml of $AlCl_3$, 0.5 ml of potassium acetate and 2 ml of pure water. The mixture was incubated for 30 min at ambient temperature. Then, the absorbance was measured at 415 nm by using a spectrophotometer. The concentration of flavonoids was measured by use of a calibration curve of quercetin (0.1mg/mL) as standard**.** The concentration of oxalates was determined by titration method as recorded by [9] where One (1) gram of dried powdered sample was added to into 100 ml conical flask and adding 75 ml of sulphuric acid then stirring for one hour using a magnetic stirrer. The mixture was then filtered using filter paper (Whatman No.

4) and 25 ml of the filtrate titrated while still hot alongside with potassium permanganate ($KMnO_4$) solution (0.05 M) up to the end.

The concentration of phytates was determined as documented by [55], by taking 0.5 grams of the dried powdered sample and mixed with 25 ml of trichloroacetic acid (3 %, w/v) and centrifuged at 3500 rpm for 15 min. The concoction was then treated with Iron III chloride ($FeCl_3$) solution and the precipitate used in spectrophotometric method at 470 nm for determination of phytates. Atomic ratio of 4:6 Fe/P was used to determine the phytic acid levels.

2.6 Data analysis

The collected data was subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) of the statistical analysis system for significant tests. The significant means at the F test were compared using Tukey's Honest test performed at a 5% significance level to determine differences among treatment means due to its ability to control family-wise error effects [14].

3.0RESULTS

3.1 Chemical composition of kitchen and cow dung bio-slurry used during the experiment

The results (**Table 3**) show the levels of bulky density, dry matter, moisture content, pH (H_2O), NH_4, NO_3, HCO_3, EC, Exchangeable phosphorus, Exchangeable potassium, exchangeable calcium, exchangeable magnesium, exchangeable iron, exchangeable zinc, exchangeable copper, exchangeable sodium and exchangeable manganese. The bulk density of the bio-slurry was recorded as (0.25 ± 0.02 g/cm^3) and (0.52 ± 0.04 g/cm^3) from kitchen source feedstock and cow dung source feedstock, respectively. The percentage moisture content of the bio-slurry from kitchen source feedstock and cow dung source feedstock was (54.8 ± 3.93% and (62.1 ± 4.21 %) respectively. The pH (H_2O) level of kitchen waste bio-slurry fertilizer was (7.2 ± 0.90), and that of cow dung bio-slurry fertiliser was (6.9

± 0.51). HCO_3 for the kitchen waste bio-slurry fertiliser was (3968.9 ± 52.40 mg/kg), and cow dung bio-slurry fertiliser was (5560.3 ± 45.72 mg/kg). NH_4 for cow dung bio-slurry fertiliser was (125.5 ± 10.91 mg/kg) while that from kitchen waste was (110.3 ± 10.42 mg/kg). NO_3 for cow dung bio-slurry fertiliser was (2.96 ± 0.34) and kitchen waste bio-slurry fertilizer was (2.4 ± 0.42).

Dry matter for kitchen bio-slurry was recorded (45.2 ± 3.62%), and cow dung source feedstock was (37.9 ± 3.71%). The electrical conductivity for kitchen waste bio-slurry fertilizer was recorded as (5.33 ± 0.32 mS/cm), and that of cow dung bio-slurry fertilizer was (6.99 ± 0.63 mS/cm). The exchangeable phosphorus for kitchen bio-slurry fertiliser was (20.2 ± 2.85 mg/kg), and that of cow dung bio-slurry fertiliser was (27.6± 3.45 mg/kg). The exchangeable ($Ca^{2+,}$ Mg^{2+}, K^+, and Na^+) for the two bio-slurry fertilisersamples exhibited the following pattern (K^+> Na+ > Mg^{2+}> Ca^{2+}). The kitchen waste bio-slurry fertiliser and cow dung bio-slurry fertilizer recorded exchangeable Ca^{2+} (0.42 ± 0.02 cmolc/kg) and (0.29 ± 0.01 cmolc/kg), respectively. For exchangeable $K^{+,}$ it was (3.13± 0.22 cmolc/kg) and 2.12± 0.33cmolc/kg) for kitchen waste and cow dung source feedstock, respectively, while for exchangeable Mg^{2+} it was recorded as(0.45 ± 0.02 cmolc/kg)and (0.42 ± 0.03 cmolc/kg) for kitchen waste and cow dung respectively. The exchangeable Na^+ concentration for the bio-slurry was (1.35 ± 0.15 cmolc/kg)and (1.26 ± 0.21 cmolc/kg) for kitchen waste and cow dung, respectively. The Exchangeable Copper was recorded as (0.28 ± 0.03 mg/kg) for cow dung bio-slurry fertilizer and (0.35 ± 0.04 mg/kg) for bio-slurry fertiliser from kitchen waste. The exchangeable (phosphorus, iron, zinc and copper) exhibited the following trend. The exchangeable phosphorus (27.6 ± 3.45 mg/kg)>exchangeable Iron (1.36 ± 0.25 mg/kg) > exchangeable sodium (1.26 ± 0.21 cmol/kg) >exchangeable zinc (0.62 ± 0.03 mg/kg) >exchangeable copper (0.28 ± 0.03 mg/kg) for cow dung. While kitchen waste bio-slurry fertiliser exhibited phosphorus (20.2 ± 2.85 mg/kg) >Exchangeable sodium (1.35 cmol/kg) >exchangeable iron (1.24 mg/kg) > exchangeable zinc (0.72 ± 0.08 mg/kg)>exchangeable copper (0.35 ± 0.04 mg/kg).

Table 3. Chemical composition (Mean ± Standard Deviation) of kitchen and cow dung bio-slurry fertiliser

Parameter	Cow dung bio-slurry fertiliser	Kitchen waste bio-slurry fertiliser
Bulk density (g/cm3)	0.52±0.04	0.25±0.02
Dry matter (%)	37.9±3.71	45.2±3.62
Moisture content (%)	62.1±4.21	54.8±3.93
pH (H_20)	6.9±0.51	7.2±0.90.
NH_4 (mg/kg)	125.5±10.91	110.3±10.42
NO_3 (mg/kg)	2.96±0.34	2.43±0.42
HCO_3 (mg/kg)	5560.3±45.72	3968.9±52.40
Electrical conductivity (mS/cm)	6.99±0.63	5.33±0.32
Exchangeable phosphorous (mg/kg)	27.6±3.45	20.2±2.85
Exchangeable potassium (cmol/kg)	2.12±0.33	3.13±0.22
Exchangeable calcium (cmol/kg)	0.29±0.01	0.42±0.02
Exchangeable magnesium (cmol/kg)	0.42±0.03	0.45±0.02
Exchangeable iron (mg/kg)	1.36±0.25	1.24±0.19
Exchangeable zinc(mg/kg)	0.62±0.03	0.72±0.08
Exchangeable copper (mg/kg)	0.28±0.03	0.35±0.04
Exchangeable sodium (cmol/kg)	1.26±0.21	1.35±0.15
Exchangeable manganese (cmol/kg)	1.12±0.09	1.21±0.07

Values represent the means ± standard deviations

3.2 Physical and chemical composition of soil before the cropping season

The results (**Table 4**) show the levels of the soil bulky density, porosity, moisture content, pH (H_2O), electrical conductivity, cation exchange capacity, organic carbon, exchangeable nitrogen, exchangeable phosphorus, exchangeable potassium, exchangeable calcium, exchangeable magnesium, exchangeable iron, exchangeable zinc, exchangeable copper, exchangeable sodium and exchangeable manganese. The soil pH under the shade net was (7.45 ± 1.34) while that of under open field was (7.25 ± 1.24). The bulky density for the two soil samples was (1.90 ± 0.26 g/cm^3) and (1.85 ± 0.21 g/cm^3) for shade net end open field, respectively. The soil porosity was recorded as (17.35 ± 1.52 %) and (15.79 ± 1.57 %) for the shade net and the open field, respectively.

The electrical conductivity of the soil under the shade net was (0.58 ± 0.04 mS/cm), and that of the open field was (0.47 ± 0.02 mS/cm). The soil organic carbon for the soils was recorded as (3.10 ± 0.09 mg/g) and (3.43 ± 0.02 mg/g) for the shade net and the open field, respectively. Phosphorus level was (16.58 ± 2.42 mg/kg) and (15.65 ± 1.98 mg/kg) under shade net and open field, respectively. The exchangeable Nitrogen level for the soil under shade net and open field was (0.34 ± 0.02 mg/g) and (0.32± 0.01 mg/g). The exchangeable sodium was (0.10 ± 0.00 cmol/kg) while that under the open field was (0.11 ± 0.00. cmol/kg)

Table 4. Soil property before cropping season

Parameter	Shade net	Open field
Bulkdensity (g/cm^3)	1.90±0.26	1.85±0.21
Porosity (%)	17.35±1.52	15.79±1.57
Moisture content (%)	18.21±2.37	17.63±2.35
pH (H_20)	7.45±1.34	7.25±1.24
Electric conductivity (mS/cm)	0.58±0.04	0.47±0.02
Cation exchange capacity (meq/100g)	4.35±0.90	4.05±0.85
OC (mg/g)	3.10±0.09	3.43±0.02
Exch N (mg/g)	0.34±0.02	0.32±0.01
Exch. P (mg/kg)	16.58±2.42	15.65±1.98
Exch K (cmol/kg)	1.07±0.09	1.05±0.07
Exch Ca (cmol/kg)	1.13±0.15	1.09±0.09
Exch Mg (cmol/kg)	1.22±0.10	1.14±0.07
Exch Fe (mg/kg)	17.60±2.45	15.64±2.31
Exch Zn (mg/kg)	20.14±2.72	20.11±2.41
Exch Cu (mg/kg)	1.67±0.13	1.55±0.09
Exch Na (cmol/kg)	0.10±0.00	0.11±0.00
Exch Mn (cmol/kg)	0.27±0.04	0.22±0.03

Values represent the means ± standard deviations

The exchangeable (Ca^{2+}, Mg^{2+}, K^+ and Na^+) in the soil samples exhibited the following pattern (Ca^{2+}> K^+> Mg^{2+}> Na^+). Quantitatively, these cations were as follows: (1.13 ± 0.15 cmolc/kg), (1.07 ± 0.09 cmolc/kg), (1.22 ± 0.10 cmolc/kg) and (0.10 ± 0.00 cmolc/kg) for Ca^{2+}, Mg^{2+}, K^+ and Na^+) respectively under the shade net. While under the open field, it was(1.09 ± 0.09 cmolc/kg), (1.05 ± 0.07 cmolc/kg), (1.14 ± 0.07 cmolc/kg), and (0.11 ± 0.00

cmolc/kg for exchangeable (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) respectively.The cation exchange capacity for the soil under the shade net was (4.35 ± 0.9 meq/100g) while that of the open field was(4.05 ± 0.85 meq/100g).

3.3 Summary statistics.

The results (**Table 5**) show a summary of statistical analysis on the effect of cover, treatment and interaction of cover with treatment and the coefficient variance. The p-value due to the effect of cover was (p= 0.0106), (p= 0.0004), (p= 0.0464), (p< .0001), (p< .0001), (p= 0.571), (p= 0.0014), (p= 0.571), (p= 0.0003), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p= 0.0622), (p= 0.0012) and (p<.0001) for moisture, protein, fats, ash, carbohydrates, phenolic, flavonoids, tannins, oxalates, phytates, carotenoids, chlorophyll, phosphorus, calcium, magnesium, iron, zinc and sodium respectively. While the p-values of leaf moisture, protein, fats, ash, carbohydrates phenolic, flavonoids, tannins, oxalates, phytates, carotenoids, chlorophyll, phosphorus, calcium, magnesium, iron, zinc and sodium due to effect of treatment application was (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (p< .0001), (P< .0001), (p< .0001), (p< .0001),(p< .0001), (p< .0001),(p< .0001), (p< .0001), (p< .0001) and (p= 0.0012), respectively. The p-values on the effect of cover, apart from phenolic and iron, were significant since the statistical analysis was performed at a 5% level of significance.

Interaction between cover and treatment did not have any significant, (p= 0.9984), (p=0.9984), (p= 0.9982), (p= 0.9983), (p= 0.9993), (p= 0.9875),(p= 0.9952), (p= 0.9818), (p= 0.9424), (p= 0.9375), (p= 0.4150) (p= 0.9413), (p= 0.9087), (p= 1.0000), (p= 0.9996), (p= 0.9574), (p= 0.9791) and (p= 0.9977) effect on leaf moisture, protein, fats, ash, carbohydrates phenolic, flavonoids, tannins, oxalates, phytates, carotenoids, chlorophyll, phosphorus, calcium, magnesium, iron, zinc and sodium.

Table 5. Summary statistics on the effect of bio-slurry fertiliser on the nutritional composition of shade net-grown Swiss chard

Parameters	P values			CV (%)
	Cover	Treatments	Cover × Treatment	
Moisture	0.0106	<.0001	0.9984	12.6
Protein	0.0004	<.0001	0.9984	6.1
Fats	0.0464	<.0001	0.9982	14.1
Ash	<.0001	<.0001	0.9983	6.3
Carbohydrate	<.0001	<.0001	0.9993	5.1
Phenolic	0.571	<.0001	0.9875	11.8
Flavonoids	0.0014	<.0001	0.9952	7.5
Tannins	<.0001	<.0001	0.9818	7.0
Oxalate	0.0003	<.0001	0.9424	8.9
Phytates	<.0001	<.0001	0.9375	6.8
Carotenoids	<.0001	<.0001	0.4150	5.4
Chlorophyll	<.0001	<.0001	0.9413	7.1
Phosphorus	<.0001	<.0001	0.9087	6.1
Potassium	<.0001	<.0001	1.0000	2.8
Calcium	<.0001	<.0001	0.9996	6.2
Magnesium	<.0001	<.0001	0.9574	5.3
Iron	0.0622	<.0001	0.9996	6.3
Zinc	0.0012	<.0001	0.9791	6.8
Sodium	<.0001	0.0004	0.9977	8.1

3.4 Effect of Cover on the nutritional composition of shade net grown Swiss chard

The results concerning the effect of cover on the nutritional composition of Swiss chard are shown in Tables 6 and 7. The cover did not have any significant (p= 0.5712) and (p=0.0622) effect on phenolic and iron content, respectively. There was a significant difference between shade net and open field in the nutritional composition. Shade net recorded higher concentrations of attributes; moisture (12.2%), fat (2.46%), ash (3.0%), flavonoids (4.7%), and oxalates (5.1%) were higher under shade net compared to open field while protein (44.6%), carbohydrates (67.6%) tannins (728.2%), phytates (248.0%), carotenoids (93.5%) and Chlorophyll (11.8%) was higher under the open field compared to shade net. Notably, open field had higher levels compared to shade net about phosphorus (45.4 mg/kg), magnesium (29.4 cmol/kg), zinc (0.72 mg/kg) and sodium (545.8 cmol/kg), while shade net had higher levels of potassium (805.2 cmol/kg) and calcium (54.8 cmol/kg)

Table 6.Effect of cover on proximate composition and gross energy contents of shade net grown Swiss chard

Cover	Moisture	Protein	Fat	Ash	Carbohydrates	Phenolic	Flavonoids	Tannins	Oxalates	Phytates	Carotenoids	Chlorophyll
Shade net	12.2[a]	41.3[b]	2.46[a]	3.0[a]	60.6[a]	1.2[a]	4.7[a]	613.9[b]	5.1[a]	205.2[b]	66.8[b]	10.0[b]
Open field	11.0[b]	44.6[a]	2.2[b]	2.7[b]	67.6[b]	1.1[a]	4.3[b]	728.2[a]	4.5[b]	248.0[a]	93.5[a]	11.8[a]
CV	12.6	6.1	14.1	6.3	5.1	11.8	7.5	7.0	8.9	6.8	5.4	7.1
p-value	0.0106	0.0004	0.0464	<.0001	<.0001	0.5712	0.0014	<.0001	0.0003	<.0001	<.0001	<.0001

*Means within a column followed by the same letter are not significantly different (Tukey's test at P = 0.05

Table 7. Effect of cover on the mineral composition of shade net grown Swiss chard

Cover	P	K	Ca	Mg	Fe	Zn	Na
Shade net	37.3[b]	805.2[a]	54.8[a]	25.1[b]	2.6[a]	0.67[b]	444.8[b]
Open field	45.4[a]	760.6[b]	49.3[b]	29.4[a]	2.5[b]	0.72[a]	545.8[a]
CV							
p-value	<.0001	<.0001	<.0001	<.0001	0.0622	0.0012	<.0001

*Means within a column followed by the same letter are not significantly different (Tukey's test at P = 0.05

3.5 Effect of treatment on the nutritional compositionof shade net grown Swiss Chard

The results concerning the effect of treatment on the nutritional composition of Swiss chard are shown in Tables 8 and 9. This study exhibited that there was no significant interaction between bio-slurry fertiliser treatments and cover. However, the bio-slurry treatment as a key factor significantly influenced the nutrient composition of Swiss chard.

The moisture level was recorded higher under T7 (13.7%) but with no significant difference compared to T4 (13.1%) and T5 (13.4%). It was comparable with T2 (11.6%) and T6 (11.7%).

The results revealed that plants planted under treatment T6 (48.85%) recorded the highest level of protein compared to control, though comparable with T4 (45.7%), T5 (45%) and T7 (45.1%). Regarding fat content, T5 (3.07%) recorded the highest fat concentration. Nevertheless, it was comparable to T6 (2.7%) and T7 (2.7%). From the results, it clearly shows that higher ash content was recorded under treatment T4 (3.1%) and treatment T5

(3.1%).T4 (3.1%) and T5 (3.1%) did not have any significant difference compared to T7 (3.0%).T4 (3.1%) and T5 (3.1%) was comparable with T2 (2.8%) and T3 (2.9%). From the results, the highest amount of carbohydrate was recorded on plants under treatment T7 (71.3%), which was also comparable with plants under T5 (64.9%) and T6 (68.1%).

A higher concentration of phenolic was observed on T7 (1.3 mg/100g)and T4 (1.3 mg/100g). T7 (1.3 mg/100g) and T4 (1.3 mg/100g) was comparable with T5 (1.2 mg/100g)and T6 (1.2 mg/100g). Flavonoids were higher on treatment T4 (5.0 mg/100g) and T5 (5.0mg/100g). T4 (5.0 mg/100g) and T5 (5.0 mg/100g) was comparable to T2 (4.4 mg/100g). T4 (5.0 mg/100g) and T5 (5.0 mg/100g)did not have any significant difference compared to T3 (4.8 mg/100g) and T7. T7 (741.6 mg/100g) was observed to be highest in tannins concentration compared to T1 (510.9 mg/100g) and T5 (647.4 mg/100g), but statistically comparable with T6 (734.0 mg/100g), T4 (729.1 mg/100g), T3 (674.4 mg/100g), and T2 (660.3 mg/100g). From the results it was observed that oxalates were higher on treatment T7 (5.7mg/100g) compared to T1 (3.3 mg/100g), T2 (4.6 mg/100g), T3 (4.9 mg/100g) and T6 (4.8 mg/100g) .T7(5.7 mg/100g) was comparable with T5 (5.0 mg/100g) and T4 (5.2 mg/100g).

The highestphytates content was highest on treatment T7 (275.6 mg/100g), and the lowest was recorded on treatment T2 (173.7). Carotenoids were recorded highest under treatment T7 (91.0 mg/100g) and comparable with T3 (83.2 mg/100g) and T4 (88.1 mg/100g). Chlorophyll content was highest on treatment T4 (11.8%) but did not have any significant difference with T2 (10.8%), T3 (11.1%), T5 (11.7%), T6 (11.1%) and T7 (11.1%). T1 (8.9%) had the least chlorophyll content. Regarding phosphorus concentration in leaf tissue, the highest phosphorus content was recorded under treatment T2 (45.5 mg/kg), which was also comparable to treatmentT3 (42.6 mg/kg), T4 (42.7 mg/kg), T5 (42.8 mg/kg) and T7 (42.5 mg/kg).

Potassium concentration was recorded highest under treatment T4 (820.9 cmol/kg), which was also comparable with T2 (812.7 cmol/kg), T3 (790.2 cmol/kg) and T7 (792.5 cmol/kg) and the lowest was T1 (720.5 cmol/kg). Concerning calcium concentration, plants under

treatment T6 (56.3 cmol/kg) recorded the highest calcium content that did not have any significant difference with T7 (55.9 cmol/kg). Plants on treatment T6 (56.3 cmol/kg) were comparable with plants on treatment T3 (53.4 cmol/kg), T4 (52.6 cmol/kg) and T5 (53.8 cmol/kg) in terms of calcium content.

Table 8. Effect of treatment on proximate composition and gross energy contents of shade net grown Swiss chard

Trt	Moisture	Protein	Fat	Ash	Carbohydrates	Phenolic	Flavonoids	Tannins	Oxalates	Phytates	carotenoids	chlorophyll
T1	7.6^{c}	31.7^{c}	1.6^{d}	2.6^{bc}	54.9^{c}	0.8^{c}	3.6^{c}	510.9^{c}	3.3^{c}	173.7^{d}	58.3^{d}	8.9^{b}
T2	11.6^{ab}	41.9^{b}	1.9^{dc}	2.8^{abc}	62.8^{b}	1.1^{bc}	4.4^{ab}	660.3^{ab}	4.6^{b}	220.8^{c}	81.4^{bc}	10.8^{a}
T3	10.1^{bc}	42.1^{b}	2.0^{dc}	2.9^{ab}	62.0^{b}	1.1^{bc}	4.8^{a}	674.4^{ab}	4.9^{bc}	226.3^{bc}	83.2^{abc}	11.1^{a}
T4	13.1^{a}	45.7^{ab}	2.3^{bc}	3.1^{a}	64.8^{b}	1.3^{a}	5.0^{a}	729.1^{ab}	5.2^{ab}	249.5^{ab}	88.1^{ab}	11.8^{a}
T5	13.4^{a}	45.0^{ab}	3.07^{a}	3.1^{a}	64.9^{ab}	1.2^{ab}	5.0^{a}	647.4^{b}	5.0^{ab}	232.8^{bc}	81.3^{bc}	11.7^{a}
T6	11.7^{ab}	48.8^{a}	2.7^{ab}	2.5^{c}	68.1^{ab}	1.2^{ab}	4.0^{bc}	734.0^{ab}	4.8^{b}	207.6^{c}	77.7^{c}	11.1^{a}
T7	13.7^{a}	45.1^{ab}	2.7^{ab}	3.0^{a}	71.3^{a}	1.3^{a}	4.8^{a}	741.6^{a}	5.7^{a}	275.6^{a}	91.0^{a}	11.1^{a}
CV	12.6	6.1	14.1	6.3	5.1	11.8	7.5	7.0	8.9	6.8	5.4	7.1
Trt p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Cover* Trt	0.9984	0.9492	0.9982	0.9983	0.9993	0.9875	0.9952	0.9818	0.9424	0.9375	0.4150	.9413

*Means within a column followed by the same letter are not significantly different (Tukey's test at P = 0.05

The results revealed that magnesium concentration was highest under T7 (31.4 cmol/kg). The lowest magnesium concentration was recorded under treatment T1 (20.2 cmol/kg). T7 (31.4 cmol/kg) was comparable with T4 (29.5 cmol/kg) and T6 (30.4 cmol/kg). Likewise, treatment T7 (3.0 mg/kg) recorded the highest iron content, which was also comparable with T4 (2.9 mg/kg). Zinc concentration was observed to be highest under treatment T5 (8.0 mg/kg), T6 (8.0 mg/kg) and T7 (8.0 mg/kg). The lowest was recorded under treatment T1 (0.5 mg/kg). T5 (8.0 mg/kg), T6 (8.0 mg/kg) and T7 (8.0 mg/kg) were comparable with T2 (0.7 mg/kg), T3 (0.7 mg/kg) and T4 (0.7 mg/kg). Sodium concentration was noted higher

under treatment T7. The least was observed under treatment T1.T7 was comparable to T2, T3, T4, T5 and T6.

Table 9. Effect of treatment on the mineral composition of shade net grown Swiss chard

Trt	Phosphorus	K	Ca	Mg	Fe	Zn	Na
T1	33.6^{c}	720.5^{d}	43.0^{c}	20.2^{d}	2.1^{d}	0.5^{c}	407.4^{b}
T2	45.5^{a}	812.7^{ab}	49.0^{b}	25.4^{c}	2.5^{c}	0.7^{b}	505.4^{a}
T3	42.6^{ab}	790.2^{abc}	53.4^{ab}	28.5^{b}	2.6^{bc}	0.7^{b}	505.2^{a}
T4	42.7^{ab}	820.9^{a}	52.6^{ab}	29.5^{ab}	2.9^{ab}	0.7^{ab}	527.9^{a}
T5	42.8^{ab}	773.0^{bc}	53.8^{ab}	25.5^{c}	2.5^{c}	0.8^{a}	509.6^{a}
T6	39.9^{b}	770.8^{d}	56.3^{a}	30.4^{ab}	2.4^{c}	0.8^{a}	489.3^{a}
T7	42.5^{ab}	792.5^{abc}	55.9^{a}	31.4^{a}	3.0^{a}	0.8^{a}	522.1^{a}
CV	6.1	2.8	6.2	5.3	6.3	6.8	8.1
P-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0004
Cover*Trt	0.9087	1.0000	0.9996	0.9574	0.9996	0.9791	0.9977

***Means within a column followed by the same letter are not significantly different (Tukey's test at P = 0.05**

4.0 DISCUSSION

Concerning the moisture content of plant tissue, it was high under the shade net this could be because the shade net conserved soil moisture and improved water status in the plant through a reduction in the rate of transpiration, therefore increasing water use efficiency. This finding agrees with the results from the experiment conducted by [24], which showed that the leaf moisture improved as the shade level increased. Higher ash concentration was recorded under a shade net environment. The higher ash level under shade net could be due to the improved mineral nutrient absorption. The higher the mineral content, the higher the ash content since ash levels are related to the total mineral content. The results of the current experiment are contrary to the results of a study conducted by [33], who noted ahigher ash content, in roselle (*hibiscus sabdariffa*) genotypes in unshaded conditions with genotype ZM 5738 having the highest.

Higher protein concentration was recorded under open field environment. The high protein level under open fields could be due to the improved mineral nutrient absorption. This was due to improved soil temperature under the open field that enhanced nutrient absorption and translocation [38]. The higher the mineral content, the higher the protein content since

protein levels are related to the total mineral content. It could also be because phenylalanine is the main precursor in the phenylpropanoid pathways, resulting in the synthesis of the protein. Once the irradiance, water and nutrients are adequate, growth is the priority, and most of the phenylalanine is utilised for the synthesis of protein [11]. The leaves under shade net recorded higher fat concentration; this could be becauseshaded plants have potential leaves, which have higher levels of certain lipids which are more adapted to low-light environments. The leaves under a shade net have higher levels of membrane lipids to sustain cellular functions under a shaded environment [48]

The current study recorded higher levels of carbohydrates in plants in open fields; this might be due to conducive light intensity and temperature that increased carbohydrate biosynthetic enzyme activity and increased translocation. The carbohydrate concentration in vegetables is mostly influenced by light intensity and temperature. Carbohydrates are synthesised through the process of photosynthesis utilising light energy. Plants make use of the Calvin cycle in the photosynthesis process to supply energy for plants and create triose phosphate, which initiates the synthesis of carbohydrates. Triose phosphate, as well as dihydroxyacetone phosphate, is translocated from chloroplasts, which combine with aldol to form fructose, which eventually turns into glucose [1]. The results are contrary to the findings of a study conducted by [57] on tomato fruits grown under shade. The study recorded lower total soluble solids content when compared to open-field fruits.

A study conducted by [33] found that all nutritional components were highly influenced by shade. It was found that cover reduced the amount of fat, which contradicts the results of the current experiment, and protein, which supports the current experiment, while carbohydrate content improved, which contradicts the same. Bell pepper and tomato under shade net generally improved leaf and fruit mineral nutrients by conserving soil moisture and favouring leaf water content. The levels of nitrogen, phosphorus, calcium, magnesium, iron, zinc and manganese increased as the shading increased in the leaf and fruit of bell pepper [24].

The results revealed that plants under shade net recorded higher oxalate content compared to plants under open fields. Oxalic acid and its associated salts arise as products of the metabolism process in plant tissues. This higher oxalic level under the shade net could be due to a change in balance towards biosynthesis other than degradation. The results of the current study agree with a study carried out by [33], who found that oxalate content was higher in plants under shaded environments, which were also slower in growth since the plants were shorter and had fewer branches. From the human nutritional viewpoint, a high content of oxalate is detrimental as it increases the danger of medical conditions like bladder stones [33]

The results revealed that shade nets improved flavonoid levels. This could be due to the synthesis of more flavonoids compared to other phenolic compounds in the pathway. The higher level of phenolic compounds hinders flavonoid production by preventing the activity of the enzyme phenylalanine ammonialyase [20]. The level of flavonoids recorded was much higher under the shade net because of the high dry matter harvested under the shade net. A study conducted by [48] recorded higher total flavonoids for plant tissues under shade net compared to those under full sun.

According to the results, shade net recorded the lowest tannin levels**.** This reduction could be due to the concentration of tannin, together with the increased phenolic content that offered an active balance between the secondary metabolites. These results agree with the study conducted by [55], which showed that shade net reduced the tannin content. These results are contrary to the results recorded by [18], in which the concentration of tannins improved by 8–13% in shrubs when they were under a shaded environment

The current experiment results showed that open fields recorded higher content of carotenoids, this may be becauseplants stored several phenolic substances and antioxidants as a defensive mechanism against harmful excessive light and UV. Light plays a significant role in the production of several antioxidants like carotenoids and flavonoids [21].Plants may accumulate several phenolic substances and antioxidants as a defensive mechanism

against harmful excessive light and UV. Light plays a significant role in the production of several antioxidants like carotenoids, flavonoids, and anthocyanins [17].The amount of light (PAR) can influence the β-carotene buildup, which is the most vital carotenoid with provitamin A activity [40]. An experiment conducted by [40] found that the β-carotene degradation worsens from a temperature range of 35 °C to 40 °C**.**

Open field recorded higher chlorophyll content compared to shade net. This difference could have resulted due to radiant energy and the intensity that are responsible for the formation of the carboxydismutase enzyme, which induces the formation of chlorophyll. Therefore, a reduction in light would lead to a decrease in the formation of the carboxydismutase enzyme and result in a lower amount of chlorophyll. These results are similar to the results reported by [10], who recorded diminished chlorophyll levels with an increased shading in baby spinach. The result showed that cover treatment did not have any significant effect ($p= 0.5712$) on phenolic. These results contradict the results recorded by [6], who found that green lettuce under an open field environment increased the synthesis of phenolic compounds also in pigmented lettuce.

Higher magnesium levels were recorded on plant leaves cultivated under open fields. The greater leaf magnesium concentration under open fields could be probably because the plants had better capability to carry out photosynthesis. Magnesium is an important factor that influences chlorophyll content and photosynthetic processes in plants. The essential component of plant chlorophyll has magnesium atoms that play a vital role in increasing the production of chlorophyll [44]. Magnesium is a principal atom of the chlorophyll ring structure, and magnesium plays an important role in absorbing sunlight energy and transforming it into chemical energy. A study conducted by [48] recorded that magnesium supports the triggering of ribulose 1, 5-biphosphate carboxylase enzyme, which is the chief enzyme in photosynthesis activity. This activity supports the fixation of carbon dioxide that was facilitated by the initiation of phosphoenolpyruvate with the assistance of magnesium ions.

Higher levels of calcium were observed on plant leaves that were under shade net. This might be due to improved uptake of plant nutrients because of improved soil temperature within the root environment, which led to plant growth and improved nutrient uptake and translocation. Also, light spectral quality could have affected leaf mineral nutrition through stomata control, transpiration, and carbohydrate translocation. In addition, since calcium uptake by the plant is associated with transpiration flux, it could be likely that plants under shade net might have had high leaf calcium levels because of the xylem flow that was directed to the extremely transpiring leaves. These results agree with the findings recorded by [4], who recorded a high rate of transpiration due to low relative humidity that improved the uptake and translocation of minerals. Also, a study conducted by [54] reported that an increased stomata conductance improved the amount of xylem volume flow and, therefore, improved nutrient translocation. For Iron concentration, shade net did not have any significant effect ($p= 0.0622$). These results agree with [19], who reported that the use of shade cloth did not affect the leaf iron concentration of apple tree leaves

Higher concentrations of zinc and sodium noted under the open field might be due to the presence of light intensity, which is the main factor that influences the opening and closing of the stomata, further affecting the rate of transpiration. A higher rate of transpiration eventually affects the uptake, translocation, and distribution of nutrients within the plant roots and leaves since roots are in direct contact with plant nutrients in hydroponic systems.

Chlorophyll content was highest on treatment T4, which might be due to the bio-slurry fertiliser that contains nitrogen, phosphorus, Sulphur, magnesium and other plant nutrients that make chlorophyll, protein and lamella film [53]. The application of bio-slurry fertiliser can effectively increase chlorophyll concentration in leaves [58]. The improvement of electron transport and opening of stomata is useful to the improvement of sunlight energy capture, conversion efficiency and the rate of carbon dioxide fixation, hence increasing the capacity of photosynthesis of the leaves [52]. A study conducted by [31] revealed that bio-slurry might

significantly improve leaf nitrogen and chlorophyll concentration and improve the rate of photosynthetic, rate of transpiration as well as stomatal conductance. Chlorophyll concentration and the carboxylase process influence the rate of photosynthesis. Nitrogen is the main constituent of chlorophyll and carboxylase. Therefore, the appropriate application of nitrogen can increase the nitrogen and chlorophyll concentration of leaves and extend the functioning period of the leaves [31]. Bio-slurry is a liquid organic fertiliser that is of high quality. Even though its plant nutrients are lower compared to those of synthetic fertilisers, after anaerobic digestion, nitrogen, phosphorus, potassium and other plant nutrients occur in an efficient form, which is easy to absorb by the plants and more favourable for promoting plant growth [29]. Assimilates are the foundation material of crop yield and quality. The elements of promoting the production and buildup of assimilates have evident potential to improve yield and quality [26]. Bio-slurry fertiliser comprises amino acids, humus, organic molecules and bioactive materials required for plant growth and development. These can promote plant growth and nutrient uptake and play an important role in crop quality improvement [26], [9]. Amino acid and nitrate concentration are some of the main crop quality indicators [23]. It may be due to nitrogen in the bio-slurry fertiliser, which is one of the main plant nutrients needed for growth and development. Bio-slurry fertiliser has a substantial amount of macro and micronutrients in addition to a considerable amount of organic matter compared to other organic fertilisers [15]. These results of the study agree with the results recorded by [17], who found plants treated with bio-slurry had higher protein content.

The moisture level was recorded higher under T7, and the least was recorded under T1. The lower moisture level under the control plot T1 might be a sign that the crop could have a longer shelf. The results revealed that plants planted under treatment T6 had higher protein levels due to cow dung bio-slurry combined with inorganic fertiliser, which supplied adequate nitrogen and eventually improved the protein content. The protein content is vital as it indicates the presence of nitrogen element, which is a component of protein. The higher

amount of fat in the bio-slurry- fertiliser treated plants might be due to the higher nutritional composition levels of the bio-slurry. Bio-slurry fertiliser could be considered an excellent quality organic fertiliser. Improvement in fat levels is important for good human well-being [51].The results of the study agree with the results reported by [37].Higher ash content was recorded under treatment T4. This is because ash content is a sign of minerals in food. A crop with higher ash content is thought to have high mineral constituents [56]. The results also agree with the findings of a study conducted by [55], who found higher levels of ash in rice cultivated with cow dung as compared to poultry manure. From the results, the highest levels of carbohydrates and tannin phenolic and phytates were recorded on plants under T7. The highest carbohydrates which were recorded might be due to lower levels of protein, ash, fibre and fat. From the results, it was observed that oxalates were higher on treatment T7 (5.7). From the human nutritional viewpoint, a high content of oxalate is detrimental as it increases the danger of medical conditions like bladder stones [33]**.**

The plants under treatment T4 recorded higher concentrations of flavonoid, which might be due to the higher nutritional properties of 100% cow dung bio-slurry applied.Higher levels of phosphorus were observed under T2. This might be due to the higher content of macronutrients available in synthetic fertilisers, which are quickly released into the soil. This result agrees with the results recorded by [35], who recorded the highest nutrient content in Swiss chard leaves cultivated using synthetic fertiliser. The results contradicted the outcomesrecoded by [16], who observed the improvement of phosphorus content on leaves of Swiss chard when grown with bio-slurry. The samples under treatment T4 had higher potassium, which might be due to the higher mineral levels in the cow dung bio-slurry. The results agree with the results reported in Maize by [27]. This finding contradicts the results of [12], who recorded that spinach and chilli plants treated with synthetic fertiliser had the highest potassium concentration, while the lowest concentration of potassium was noted in plants treated with 200% bio-slurry.

T6 recorded the highest calcium content, which might be due to the reasonable ratio of bio-slurry fertiliser and inorganic fertiliser, not only ensuring the supply of large mineral nutrients but also providing micronutrients and other substances for quality enhancement [43]. A study conducted by [54] also revealed that different ratios of bio-slurry fertliser and inorganic fertiliser application at the flowering fruiting-set phase and the fruit enlargement phase improved tomato quality. Combined application of bio-slurry fertilizer and inorganic fertiliser could encourage the improvement of micronutrients and improve the grain quality of wheat plants [43]. These results contradict results recorded by [31], which reported a higher significant content of calcium on Swiss chard leaves under control (No fertilisers) treatment.

Higher magnesium concentration was recorded under treatment T7. This might be due to bio-slurry that contains magnesium that makes up chlorophyll, protein and lamella film [53]. These results are contrary to those of [36], who recorded the highest micronutrient content on Swiss chard leaves for inorganic fertilizer-treated plants. These are similar to the records from previous findings [2]. T7 recorded the highest iron concentration, which could be due to bi-slurry mineralisation that followed in later stages that provided adequate plant nutrients. These results agree with the results by [12], who revealed that plants planted with 50% bio-slurry fertilizer recorded the highest iron concentration, while the least iron concentration was recorded in plants planted with synthetic fertilisers. However, the mean concentrations of iron in Swiss chard samples were less compared to the MPL for human consumption [14]. This showed that Swiss chard may be grown with the use of bio-slurry that is safe for human use as iron toxicities are concerned.

The results revealed that T7 had the highest concentration of zinc. The higher mean concentration of Zn might have come from the bio-slurry fertiliser, this agrees with the results from previous findings [22]. Nevertheless, the average concentrations of Zn in Swiss chard from all treatments, together with the control, were less as compared to the MPL for human

use [14]. This indicates that bio-slurry fertiliser may be used for Swiss chard growing, which is nontoxic for human consumption as Zn toxicities are concerned.

Generally, where T4 (100% cow dung bio-slurry fertiliser) and T7 (50% kitchen bio-slurry fertiliser + 50% cow dung bio-slurry fertiliser) had higher levels of tissue mineral composition might be due to the application of bio-slurry that increased the quality of vegetables. Bio-slurry fertilizer is suitable for organic farming for high-value crops. Bio-slurry fertilizer serves as a substitute for inorganic fertilisers since vegetables grown with bio-slurry fertiliser have better quality and yield than those grown with inorganic fertilisers. In addition, bio-slurry fertilizer has traces of important micronutrients such as zinc, boron, calcium, copper, iron, magnesium and Sulphur. This, therefore, increased the quality of crops, such as size might be due to nutrient enhancement [19]. Vegetable crops produced with bio-slurry fertiliser have better quality as compared to those produced with chemical fertiliser. Bio-slurry fertiliser, just as all other organic fertilisers, improves soil structure and water retention capacity, leading to more widespread root development and improved soil microorganism activity and, therefore, influencing the availability of plant nutrient concentration in soil. These results agree with the results recorded by [28], who recorded bio-slurry fertiliser as an important product of anaerobic biodigester that contains abundant plant nutrients and bioactive materials, and they showed that bio-slurry fertilizer might significantly improve vegetable quality. It was recorded that organically grown apples, potatoes, peas, wheat and sweet corn had a mean of 63 per cent higher in calcium, 73% higher in iron, 118percent higher in magnesium, 178 per cent higher in molybdenum, 91percent higher in phosphorus, 125percent higher in potassium and 60 per cent higher in zinc. A study also revealed that organically grown vegetables had higher carotenoid contents, higher mineral composition and higher phytonutrients, which could be effective in fighting against cancer [30]. Therefore, organic farming provides an opportunity to achieve nutritional security as well as environmental sustainability. According to the results, the highest sodium was noted under treatment T7.

Application of bio-slurry fertiliser at 100 % and 50% also revealed better results in nutrient elements concentration of plant leaves consistently. This is apparently due to bio-slurryfertiliser mineralisation, which might have followed in later stages to provide adequate nutrients to the plants.

5.0 Conclusion

The result generally revealed that the use of 50% cow dung bio-slurry fertiliser combined with 50%kitchen waste bio-slurry fertilizer improved the nutritional composition of shade net grown Swiss chard.Bio-slurry fertilizer has a positive effect not only on crop production improvement but also on quality enhancement. The use of bio-slurry fertilizer improves the quality of leaves produced, lowers the cost of inorganic fertiliser utilisation and improves the marketability of the crop for the economic enrichment of the farmers. Therefore, the use of bio-slurry fertilizer can lower the cost of synthetic fertiliser together with the improvement of crop production sustainability. Transforming kitchen waste resources and cow dung can provide a sustainable best way to manage kitchen waste and cow dung while creating an added benefit through enhancing soil fertility and long-term carbon sequestration, thus checking the production of greenhouse gases.

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7.0 Declaration of conflict of interests

Authors have declared that no competing interests exist.

8.0 Authors' contribution

Author 1* and 1 designed the experimental study, performed the statistical analysis, wrote the protocol, and all the authors wrote the first draft of the manuscript, read and approved the final manuscript.

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