Safety of Traditional Leafy Vegetable Powders from Lindi in Tanzania

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Abstract

Postharvest losses in the fruits and vegetables sector remain a major problem in the world, and especially in Sub Saharan Africa. Up to 50% of fruits and vegetables produced in developing countries is lost in the supply chain between harvest and consumption. Though WHO recommends consumption of at least 400 grams of fruits and vegetables daily, the actual consumption is much less. Two billon people are still suffering from micronutrient deficiencies and almost 800 million from caloric deficiencies on a global scale (Achadi et al., 2016). Lindi in Tanzania, is among the most affected in the country. To combat this problem, one of the interventions that can be used to address the problem is to preserve vegetables. In this study, three types of Traditional Leafy Vegetables (TLVs) - Amaranths (AML), Sweet potato (SPL) and Cassava leaves (CAL), grown in Ruangwa and Nachingwea Districts in Lindi Region were carefully collected from Home Gardens (HG) and Low Land (LL). They were solar dried and made into powders that had been optimized for Iron content. The vegetable powders were then mixed with water and spices to make four (4) soup formulations. The safety of these products had not been determined. This study was therefore conducted to evaluate the microbiological quality (Total plate count and E. coli) of the vegetable powders. Significant differences ($p \leq 0.05$) in microbial load among raw vegetables were observed. Sample CAL had the highest load (3.67×10^2) whereas sample SPL had the lowest (3.15×10^2). The microbial load between the two sites also differed significantly ($p < 0.05$). However, there were no significant differences ($p \geq 0.05$) in microbial quality of the vegetable powders, all of which were below the TBS standards. No E. coli was detected in any of the samples studied. The absence of E. coli in the samples indicates appropriate handling of the vegetables. With the year 2021 being the International year of fruits and vegetables, it is crucial to raise awareness of their role in human nutrition, food security and health. Consuming sufficient fruits and vegetables is important as a source of micronutrients and support the immune systems. They also lower risk of depression and anxiety, obesity and non-communicable diseases; promote gut health (UN news, 2020). Thus, solar dried TLVs and the developed products are recommended for use due to their safety and quality. These TLVs are a potential source of micronutrients if properly processed and utilized.

Key words: Micronutrients, Vegetables soup powder, Safety, E. coli, Solar drying

Introduction

Vegetables are low in calories, high in fiber content and are also the best sources of antioxidants and other phytonutrients (Niththiya *et al.,* 2014). Adequate vegetables consumption can be protective to some chronic diseases such as diabetes, cancer, obesity, metabolic syndrome, cardiovascular diseases, as well as improve risk factors related with these diseases (Ulger *et al.,* 2018). Vegetables are abundant during the wet season but without post-harvest preservation, the excess after consumption goes to waste which limits their marketability (Chege and Kimiywe, 2016). The high moisture content of Traditional Leafy Vegetables (TLVs) renders them perishable while their seasonal availability limits their utilization all year round (Njoroge *et al.,* 2015). Due to the high perishability nature of the TLVs, most are dried without adding any preservatives so as to enhance availability throughout the year (Managa *et al,* 2020). However, solar drying is recommended for preservation of green leafy vegetables (Chege *et al.,* 2014). The removal of moisture arrests the growth and reproduction of microorganisms that would cause decay and minimizes many of the moisture mediated deterioration reactions (Ahmed *et al.,* 2013). Any microbial contamination in leafy vegetables is commonly associated with the environment through which the product has passed (Taura and Habibu, 2009). Consumption of these types of vegetables, if not prepared hygienically could be the source for ingestion of considerable numbers of human pathogenic bacteria resulting in diseases (Kimaro, 2017). Hence microbiological control is important in food industry as to prevent food borne diseases and provide safe and quality product. This study was carried out to assess the microbiological quality of raw and processed traditional leafy vegetables for health and safety of consumers.

Materials and Methods

Study area

The study was carried out at Mibure and Mitumbati, villages from Ruangwa and Nachingwea districts respectively in Lindi region. Lindi region is situated in Southern Tanzania between latitudes 70 55’ and 100 50' South of the equator and longitudes 360 51’ to 400 East. It is a coastal town located at the far end of Lindi Bay, on the Indian Ocean in Southeastern Tanzania. The dominant climate is hot and humid.

Materials

Materials used included Traditional Leafy Vegetables (TLVs) namely Amaranth leaves (*Amaranthus hybridus* L.) (AHL), sweet potato leaves (*Ipomoea batatas*) (IBL) and cassava leaves (*Manihot esculenta*) (MEL) from two villages Mtumbati and Mibure in Lindi Region, Tanzania and vegetable soup powder formulations.

Equipment used included cool box and sampling bags, weighing balance Mettler Toledo (Model XP205 from United States), Incubator Memmert (Fisher scientific model, German), Media dispenser, Herathrm oven (Model OMH180-S made in German), Colony-counting mashine (Model D-37079 made in German Centrifuge (Model 300R-Hettich, made in German), Vortex bohemia (Model K-550-GE, made in U.S.A) and pH meter (Model Orion 4 star plus, Thermo scientific, from U.S.A),petri dishes made of glass and total delivery graduated pippete in 0.1 ml division.

All chemicals used were of analytical quality, and were from Sigma-Aldrich Chema Gmbh, Germany, unless otherwise stated.

Study design

Cross sectional design was used in this study. Samples for microbiological parameters (Total plate count and *E. coli*) were drawn from three TLVs across the sites (home garden and low land

Sampling plan and data collection

Purposive sampling procedure was used to collect samples from selected points. Sampling was carried out in the morning during a rainy season from February to March 2019. Amaranths (*Amaranthus hybridus* L.) Sweet potatoes (*Ipomea batatas*) and Cassava (*Manihot esculenta*) samples were collected in duplicate from two sites, home garden (HG) and low land (LL) from Lindi. Thus, a total of 12 samples were collected i.e. 3 types of TLVs *2 points (HG and LL) *1 Region, all in duplicates, making a total of 12 sample from both sites. In addition, 4 vegetable soup formulations were also analysed in duplicates (8 samples). The total sample size was 20. These samples were analyzed in triplicate to make a total of 60 for each parameter.

Samples were collected from the sites and transported in closed polyethylene bags, which were stored in a cool box containing ice maintained at 4°C to SUGECO (Sokoine University Graduate Entrepreneurs Cooperative, SUA, Morogoro) for sample preparation and solar drying. Both solar dried vegetables and powdered soup formulations were transported to the Tanzania Bureau of Standards (TBS) laboratory for microbial analysis.

Sample preparation

About 2.5 kg of each of the fresh TLVs samples was thoroughly washed with potable water to remove adhering physical ring dust and impurities, and the leafy edible parts of the vegetables were separated from the main plant. They were then sliced, blanched with water (containing 10% of NaCl) at temperature of 80°C for 2 minutes. Addition of salts of various metals (zinc, iron, copper) helps to stabilize chlorophyll content in chlorophyll-containing vegetables hence preserve colour loss. (Belinska *et al.,* 2018). The blanched vegetables were then drained and spread on trays for 10-15 minutes. Solar drying was done at SUGECO - as per procedure by Mongi (2013) with some modifications. Blanched samples were loaded into the solar dryer. The temperature in the solar dryer ranged between 45-55°C and drying was completed in 3 days. About 1.5 kgs of each dried TLVs were packed separately in labeled freezer bags and stored at room temperature in a dark dry place. After solar drying, the dried vegetables were ground by a machine (Gaoxin 1250 gx-25, China). Each TLVs was ground separately and passed through a fine 315-micron sieve to obtain fine powders. TLVs powders were then packed in labeled food freezer bags and stored at room temperature (25°C) in a dark dry place prior to product formulations and analysis.

Product formulation

Three types of TLVs samples were used to formulate iron rich powders. Various proportions of vegetables were used based on iron optimization to meet the RDA of iron for children aged between 1-5 years (Matemu, 2018). Table 1 shows the amount of solar dried TLV samples and Table 3 shows spices used to make formulation after pretesting in the Tanzania Bureau of Standards (TBS) laboratory. The powder formulations were made by mixing 90g of solar dried TLVs with 10g of spices (F1, F2, F3 and F4). These formulations were analysed for microbiological quality.

Table 1: Soup formulations from 3 traditional leafy vegetables (90% of formulation)

Materials	(F1)	(F2)	(F3)	(F4)
(Amount per g)				
Amaranthus hybridus L (AML)	60.0	70.0	80.0	40.0
Manihot esculenta (CAL)	7.50	5.00	2.50	10.0
Ipomea batatas (SPL)	22.5	15.0	7.50	40.0

AML- amaranth leaves CAL-cassava leaves SPL-Sweet potatoes leaves

Table 2: Spices added for soup formulations

Spices	(Amount per g)
Garlic	0.5
Ginger	0.5
Coriander	0.5
Cumin	0.5
Corn Flour	4.0
Salt	2.0
Sugar	2.0
Total	100

Microbiological analyses

Media preparation and storage

All the media used in this study were prepared according to manufacturer's instructions.

Preparation of analytical sample by serial dilution

About 25g of each vegetable powder was weighed into 225mls BPW to obtain initial suspension (10^{-1}) dilution, 1ml from (10^{-1} dilution) was taken by use of sterile pipette into 9ml of 0.1% buffer peptone water to prepare (10^{-2} dilution), the above procedure was repeated for further serial dilution up to 10^{-4} dilutions.

Detection and Enumeration of *Escherichia coli*

This was done according to ISO 16649-2:2001(E). Results were expressed in CFU/g.

Detection and Enumeration of Total plate count

This was done according to ISO 4833-1:2013(E). Results were expressed in CFU/g

Expression of results

The countable bacterial colonies from two consecutive plates of each sample were converted into colony forming units per g using a formula

$$N = \sum C / (V \times (n1 + 0.1\,n2) \times d) \quad (1)$$

Where;

N = number of bacterial colonies counted,

C = sum of colonies identified on two consecutive dilution steps, where at least one contained 10 colonies,

V = volume of inoculum on each dish/plate, in ml and

d = dilution rate corresponding to the first dilution selected (the initial suspension is a dilution)

Statistical analysis

Descriptive statistics were used to describe, summarize and present data for both TLVs and vegetable soup powder formulation. Mixed level factorial was used to determine microbial quality of dried TLV and TLVP by using the following model:

$$Y_{ijkl} = \mu + \tau + \alpha_k + \tau\alpha_{ik} + \varepsilon_{ijkl} \quad (2)$$

Where,

i = 1,2

j = 1,2

k = 1,2,3

Where by:

Y_{ijk} = Dependant variable, μ=General mean, and

ε = Random error

τ_i = is the ith site effect

α_k = is the kth type of vegetable effect

Data was analyzed using R statistical package software. Analysis of Variance (ANOVA) was carried out to determine the significant differences in microbial count between solar dried vegetables and vegetable powder formulations among the 36 samples of TLVs with respect to sites type of vegetables. Means were separated using Tukey's Honest at $p<0.05$.

Results

Microbiological parameters

Microbial Load of selected Traditional Leafy Vegetables cultivated in different farm sites and their vegetable soup formulations.

Total Plate Count and *E. coli* count of selected Traditional Leafy Vegetables

The mean Total Plate Count (TPC) of selected vegetables is shown in Table 3 and Fig 1 while the mean *E. coli* count is presented in Table 4. The Total plate count reported from the studied vegetables were in the range of 102 CFU/g while *E. coli* was absent in all samples analysed. Cassava leaves had the highest bacterial load followed by amaranth and sweet potatoes. The mean TPC for all vegetables varied significantly ($p<0.05$) with cassava leaves having the highest level and sweet potato leaves had lowest. There was no *E. coli* growth in any of the vegetables (Table 4)

Bacterial load of selected Traditional Leafy Vegetables cultivated in different Farm Sites

The Mean Total Plate Count (TPC) and *E.*

Table 3: Mean Total Plate Count (CFU/g) for selected dried TLVs grown in Lindi region

Vegetables	Mean Total Plate Count (CFU/g)	(TZS1657:2014-EAS:2013) Microbiological limit (CFU/g)
AML	3.54 x 102±9.9^{b}	103
CAL	3.67 x 102±10.5^{a}	103
SPL	3.15 x 102±12.3^{c}	103

Values are expressed as mean ±SD (n=12); Mean values with different superscripts letters down the column are significantly different from each other at different at p<0.05 (Tukey's Honest). AML-Amaranth leaves; CAL-Cassava leaves; SPL- Sweet potatoes leaves. CFU-Colon forming unit, TZS-Tanzania standard –EAS-East Africa Standard

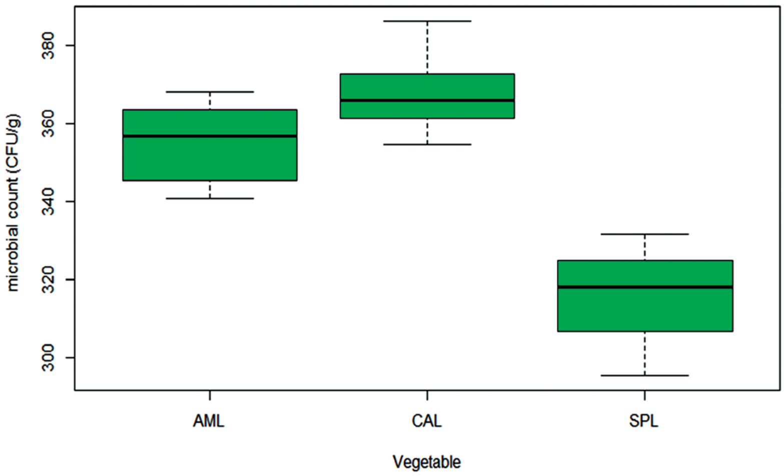

Figure 1: The mean TPC for solar dried vegetables

Table 4: Mean *E. coli* count (CFU/g) for selected dried TLVs grown in Lindi Region

Vegetables	Mean *E. coli* count (CFU/g)	(TZS1657:2014-EAS:2013) Microbiological limit (CFU/g)
AML	ND	Absent
CAL	ND	Absent
SPL	ND	Absent

Values are expressed as mean ±SD (n=12); AML-Amaranth leaves; CAL-Cassava leaves; SPL- Sweet potatoes leaves, CFU-Colony Forming Unit, NIL-Absent, ND-Not detected, TZS-Tanzania standard –EAS- East Africa Standard

coli for vegetables found in Home garden (HG) and Low Land (LL) are expressed in Table 5 and Fig. 2. Results show that the Mean TPC for all vegetables varied significantly (p<0.05) with LL vegetables having higher TPC whereas Sweet potatoes leaves had the lowest TPC. Also, from the Table 6, there was no *E. coli* among the vegetables found in the two sites.

Microbial Mean for Vegetable Soup Powder Formulation

The Mean Total Plate Count (TPC) and

Table 5: Mean Total Plate Count (CFU/ g) for samples from the two sites

Site	Mean Total Plate Count (TPC) (CFU/g)	(TZS1657:2014-EAS:2013) Microbiological Limit (CFU/g)
HG	3.40 x 102± 25.6[b]	103
LL	3.51 x 102±23.4[a]	103

Values are expressed as mean ±SD (n=18); Mean values with different superscripts letters down the column are significantly different from each other at different at p<0.05 (Tukey's Honest). HG- Home garden, LL- Low land. TZS-Tanzania standard –EAS- East Africa Standard

Table 6: Mean Microbial Load for *E. coli* across the Sites

Site	Mean *E. coli* (CFU/g)	(TZS1657:2014-EAS:2013) Microbiological limit (CFU/g)
HG	ND	Absent
LL	ND	Absent

Values are expressed as mean (n=18); HG- Home garden, LL- Low land. CFU-Colony Forming Unit, NIL-Absent ND-Not detected TZS-Tanzania standard –EAS- East Africa Standard

Table 7: Total Plate Count (CFU/g) for Vegetable Soup Powder Formulation

Vegetables	Mean Total Plate Count (CFU/g)	(TZS1657:2014-EAS:2013) Microbiological limit (CFU/g)
F1	3.42 x 102±34.19[a]	103
F2	3.45 x 102±17.81[a]	103
F3	3.52 x 102±12.08[a]	103
F4	3.64 x 102 ±16.51[a]	103

Values are expressed as mean ±SD (n=6); Mean values with different superscripts letters down the column are significantly different at different at p<0.05 (Tukey's Honest), F1-(60:7.5:22.5: A, C, S) F2-(70:5:15: AML, CAL, SPL) F3-(80:2.5:7.5, AML, CAL, SPL) F4-(40:10:40: AML, CAL, SPL), CFU-Colony Forming Unit, TZS-Tanzania standard –EAS- East Africa Standard

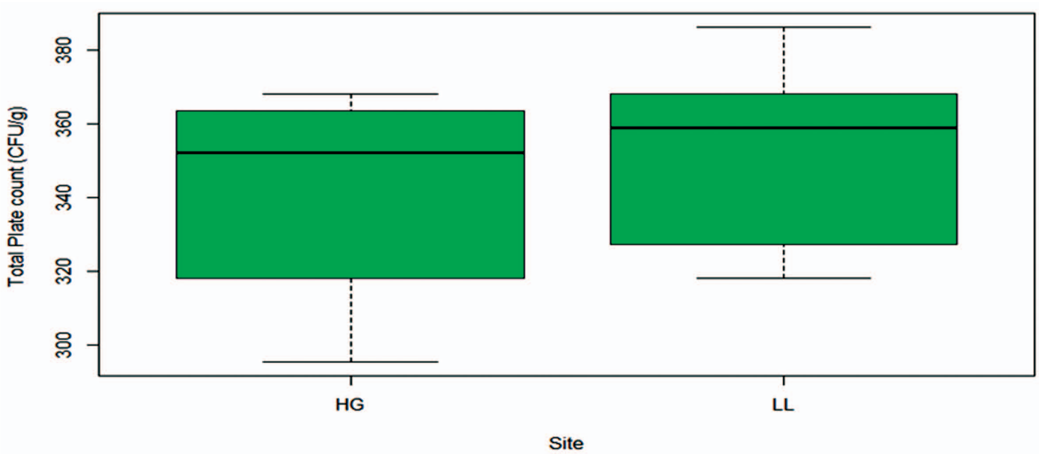

Figure 2: The mean results of Total plate count across the Sites

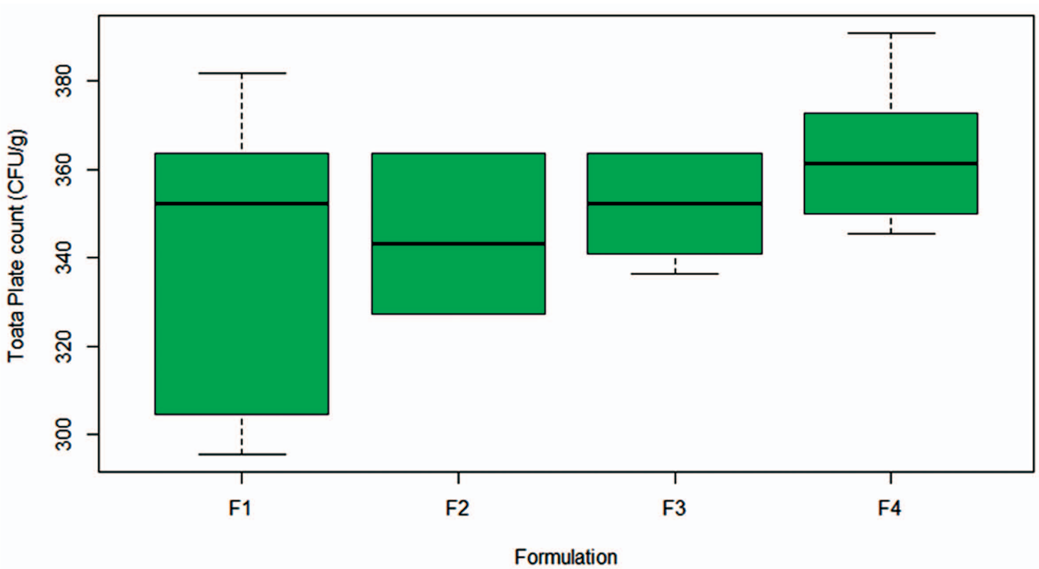

Figure 3: The mean results of Total plate count among Formulation

Mean *E. coli* for vegetables soup powder formulation are presented in Table 7 (and Figure 3) and Table 8 respectively. Though sample F4 had the highest microbial load and sample F1 the lowest, there were no significant differences ($p<0.05$) in mean TPC between any of the formulations. Also, from the Table 8, *E. coli* was not detected in any of the vegetable soup formulations.

Table 8: Microbial Mean for *E. coli* (CFU/g) in Vegetable Soup Powder Formulation

Vegetables	Mean *E. coli* (CFU/g)	(TZS1657:2014-EAS:2013) Microbiological limit (CFU/g)
F1	ND	Absent
F2	ND	Absent
F3	ND	Absent
F4	ND	Absent

Values are expressed as mean ±SD (n=6); ND-Not detected Mean values with different superscripts letters down the column are significantly different from each other at different at p<0.05 (Tukey's Honest), F1-(60:7.5:22.5: AML, CAL, SPL) F2-(70:5:15: AML, CAL, S,) F3-(80:2.5:7.5, AML, CAL, SPL) F4-(40:10:40: AML, CAL, SPL), CFU-Colony Forming TZS-Tanzania standard –EAS- East Africa Standard

Discussion

Food safety is among the most important parameters involved in the quality of food. The presence of pathogenic and deteriorating microorganisms has been extensively related to foodborne diseases or the reduced shelf life of processed vegetables (Schuh *et al.,* 2019). *Escherichia coli* is an innocuous member of the human and warm-blooded animal gut microbiota; however, pathogenic strains may cause intestinal and extra intestinal infections. These primary hosts may acquire *E. coli* from water and food (Luna-Guevara *et al.,* 2019). The test for *E. coli* assesses the cleanliness of an environment or food, and can also be used to gather information regarding the potential for contamination (Bai *et al.,* 2007) hence used as an indicator for safety. While Total Plate Count (TPC) gives a quantitative estimate of the concentration of microorganisms such as bacteria, yeast or mould spores in a sample, the TPC can be used to evaluate sanitary quality, sensory acceptability, and conformance with good manufacturing practices (GMPs). Results of the TPC can provide a food processor with information on the quality or handling history of raw materials, food processing and storage conditions, and handling of the finished product. Thus it can be used to determine the shelf-life or forthcoming sensory change in a food product (Mendonca, *et al.,* 2020).

Total Plate Count and *E. coli* count of selected TLVs

This study revealed higher TPC for dried Cassava leaves, followed by amaranth and finally sweet potatoes as indicated in Table 3. The trend may be associated with the moisture content (from the same study, but results not shown) for each vegetable where it was higher for cassava leaves (9.17±0.58) followed by amaranth (8.47±0.55) and finally sweet potatoes leaves (8.12±0.51). It is generally known that the higher the moisture content the higher the microbial load and vice versa. Removal of moisture prevents the growth and reproduction of micro-organisms which would otherwise cause food spoilage. This is the basis for food preservation and hence increased shelf life for foods with low moisture content. A decreased water activity inhibits the growth of most bacteria, yeasts, and molds, which are unable to grow below 0.87, 0.88, and 0.80, respectively (Beuchat *et al.,* 2013).

Some studies have indicated that aerobic mesophilic microorganisms found in food are important microbiological indicators for food quality, and most foods are regarded as harmful when they have large populations of these microorganisms, even if the organisms are not known to be pathogens (Weldezgina and Muleta 2016) and (Sudershan *et al.,* 2009). Factors which might be accountable for the counts may include drying vegetables on exposed surfaces and packing them in containers not adequately cleaned (Kudjawu *et al.,* 2011). However, present results furthermore indicated that microbial load was not as high (103 -105) and that the vegetables may possibly be preserved over a considerable period of time (Ukegbu and Okereke, 2013). However, it is important to note that if pathogenic microorganisms are present, these may cause food poisoning which may result into severe illnesses, depending on the dose and the type of microorganism.

The presence of *E. coli* in foods is usually due improper/poor handling during processing and preservation Several studies have indicated that high coliforms count in dried vegetables is an indication of poor handling in the whole value chain from farm to fork. Some important sources of contamination among leafy vegetables occured during pre-harvest which included soil, irrigation water, inadequately composted manure, human handling, reconstituted fungicides and insecticides. Postharvest sources included harvesting equipment, transport container, contaminated water used for washing, transport vehicles, processing equipment, unclean implements, poor hygiene of hands and cross contamination during preparation or storage (Njoroge *et al.,* 2015; Luna-Guevara *et al.,* 2019). The present study results are different from the findings reported by Victor, 2017 who indicated heavy fecal coliform contamination in vegetables ranging from 4.0 × 103 to 9.3 × 108 MPN/g) in Ghana and assign microbial contamination in vegetables to sources such as soil, manure, water and poor post-harvest handling and storage. Also Oranusi and Braide, 2012 explained that, total aerobic count (TAC) and fecal coliform (FC) are real indicator organisms (that is, for hygiene and sanitary conditions) and for this reason their presence in high numbers in dried fruits and vegetables implies poor hygiene and sanitary conditions during processing. However, from the present study as shown in Table 4, it was found that none of the dried TLVs vegetables had *E. coli.* This could be attributed to the blanching temperatures of 80°C for 2 minutes and enclosure of the samples in a solar-drier. Solar dryers are free from microbial contamination and are better preservers and give good quality products than sun dried products (Udomkun *et al.,* 2020)

Bacterial load of selected Traditional Leafy Vegetables cultivated at the two different Farm Sites

Regarding the mean microbial load of vegetables across planting sites, there was significant difference in CFU observed for Low Land (LL) compared to High Land (HL) as presented in Table 5. The observations from this study were supported by Kimaro, 2017 indicated that lower sections of the farm site registered significantly higher bacterial loads compared to the middle and upper section. At the farm, vegetable contamination can be due to contact with cattle, sheep, birds, insects and feces (Kayombo, 2018) or associated with the presence of feces from cattle and other animals, especially during heavy rainfall (Luna-Guevara, (2019). High risks of fecal contamination may have originated from people reported to be entering and/or urinating/defecating in the farms. Fertilizers, irrigation water, wild animal intrusion, insects, pesticides/fungicides, crop debris, and flooding area also potential sources of microbial contamination at production level (Kapeleka, 2020). However, practice found in the study area showed that people were not using contaminated water to irrigate vegetables and they also used toilets for urinating and defecating rather to using reserved water ponds thus no *E.coli* found. Present results further show that both TPC and *E. coli* counts were found to be lower than the maximum limit level.

Mean microbial load of vegetable soup powder formulation

The mean bacterial load was highest for F4 followed by F3, then F2, and lastly F1. The present results in Table 7 indicated that there was no significant differences ($p<0.05$) between the formulations. In addition, all TPC and *E. coli* were not above the recommended limit in accordance with TBS standard and the East African Standard (TZS1657:2014; EAS:2013). These results are in agreement with those of Farzana, (2017,) who found that the microbial quality of the vegetable soup powder formulation were 3 × 102 total plate count while no *E. coli* of which were within the acceptable limit according to Food Standards Australia New Zealand 2001. This was supported by Niththiya *et al.,* 2014 and Singh and Kaur, 2020, who reported that the product would be considered microbiologically safe if the total microbial count of dehydrated soups is less than 1x104 cfu/g. Other authors however, stated that samples with counts higher than 1.1×103 CFU/g are unfit for consumption (Schuh *et al,* 2019). The standard limit for aerobic mesophilic bacterial count for food should be less than 105 CFU/ml (Kimaro, 2017). Chege and Kiminywe (2016), found the level of microbes solar dried amaranth were within the within the levels recommended by the International Commission of Microbial Specification for Foods (ICMSF) which is 105 and absent (NIL) for TPC and *E. coli* respectively. According TBS standard (TZS1657:2014-EAS:2013) specification stated that microorganism maximum limit for Total plate count, cfu/g, was 1×103 for method of test ISO 4833 while *Escherichia coli*, (cfu/g), was Absent for method of test ISO 4832. Tables 7 and 8, show that microbes were below the maximum allowable levels for both TPC and *E. coli*. The absence of *E. coli* and meeting the limit for TPC in the tested formulation samples may signify good hygienic and handling practices. Generally, this is an indication of minimum adherence to Good Health Practices (GHP) and Good Manufacturing Practices (GMP).

Conclusion

The findings of the present study indicate that the mean TPC and *E. coli* (CFU/g) among the raw vegetables indicated higher levels in cassava than amaranth leaves, whereas sweet potatoes leaves had the lowest count. Vegetables grown under low land sites had significantly higher ($p<0.05$) mean TPC than those grown at home garden sites. No *E. coli* was found in any samples analysed in this study. For vegetable soup powder samples, the mean TPC count was of the order F4>F3>F2>F1 while no *E. coli* was found. Though the mean TPC count was high in all samples, they were all lower than the recommended levels and hence all samples were of acceptable standards. The absence of *E. coli* indicates proper handling of vegetables across the value chain. Thus the formulated vegetable soup powders may be recommended as being safe for consumption.

Recommendations

From this study it is recommended that:

i. Vegetables found in home gardens (HG) are recommended for consumer usage because of lesser colony units indicating greater microbiological quality compared to Low Land (LL) vegetables.
ii. Education must be imparted to communities on the proper handling, including storage and transportation of the vegetables and practicing hygiene since they significantly reduce microbial load in food products.
   Other studies may be conducted to determine shelf life of the formulated vegetable soups.
iii. Farmers, vegetable processors and consumers who suffer from bulk loses and microbial destruction of raw vegetables can use this idea of processing vegetables soup powder as it assured microbiological safety of the vegetables and also create new products as well as market segments.

Acknowledgments

The study was partially funded by the Veg-Leg project which was supported by funds from the Germany Federal Ministry of Food and Agriculture (BMEL) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE); Tanzania Meat Board that granted half of financial support for the study and SUA- for providing desk space for laboratory work.

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