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Microorganisms Associated with Healthy, Bruised, and Spoiled Irish (*Solanum tuberosum*) and Sweet Potatoes (*Ipomoea batatas*)

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Abstract

This study investigates the microorganisms present in healthy, bruised, and spoiled Irish and sweet potatoes and this was done using standard microbiological methods. The results reveal varying microbial counts across different stages of potato quality. In Irish potatoes, Total heterotrophic bacteria (THB) counts ranged from $3.25x10^5$ to $1.9x10^6$ CFU/g in the healthy samples, increasing to $5.7x10^5$ to $1.12x10^6$ CFU/g in the bruised samples, and further to $9.15x10^5$ to $1.71x10^6$ CFU/g in spoiled samples. Similarly, sweet potatoes exhibited THB counts from $4.15x10^5$ to $6.35x10^5$ CFU/g in healthy samples, $3.8x10^5$ to $4.55x10^5$ CFU/g in bruised samples, and $1.49x10^6$ to $2.24x10^6$ CFU/g in spoilt samples. Staphylococcus counts followed a similar trend in both potato types, with higher counts observed in bruised and spoilt samples compared to healthy ones. Total coliform counts also showed consistent increases in bruised and spoiled potatoes compared to healthy ones. Total fungal counts varied across all potato samples. Eleven bacterial genera and several predominant fungal isolates were identified through morphological and biochemical characterization including *Enterobacter* spp. 5.4%; *Lactobacillus* spp. 4.3% *Micrococcus* spp. 3.0% ,*Klebsiella* spp. 8.6%; *Proteus* spp. 8.9%; *Pseudomonas* spp. 8.6% *Citrobacter* 4.3%; *Corynebacterium* 5.4%; *Staphylococcus* spp. 20.4%; *Bacillus* spp. 20.4%; *Escherichia coli* 10.6%;; Yeast 26.5%; *Aspergillus niger* 20.4%; *Mucor* 20.4%; *Fusarium* 18.4%; Pink Yeast 6.1%; *Aspergillus flavus* 4.1%; *Rhizopus stolonifera* 2.0% and *Trichoderma* 2.0% . Nutritional analysis revealed differences in various nutritional components between healthy and bruised potatoes. These findings highlight the dynamic microbial interactions and nutritional changes occurring during potato spoilage, emphasizing the importance of improved storage and handling practices to maintain potato quality and safety.

***Keywords*:** *Microbial quality, Proximate composition, Irish and sweet potatoes*

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I. INTRODUCTION

The sweet potato (*Ipomoea batatas*) is known to have originated in the tropical regions of Central or South America, with evidence of its cultivation dating back 8,000 to 10,000 years. Its domestication occurred well before that of the Irish potato (*Solanum tuberosum*), spreading through ancient trade routes to North America, Polynesia, and parts of Asia. Despite sharing the name "potato," sweet potatoes belong to the Convolvulaceae family (morning glory family), while Irish potatoes are part of the Solanaceae family (nightshades), making them botanically unrelated.

As a dicotyledonous perennial plant, the sweet potato is notable for its edible storage roots and leaves. It is the world's seventh most vital food crop, following potato, barley, cassava, wheat, rice and maize and is cultivated in over 100 countries (Suraji *et al*., 2013). With a global average productivity of 15 tons per hectare, worldwide production exceeds 105 million metric tons annually (FAO, 2008). Sweet potatoes are particularly prominent in tropical and subtropical regions, appreciated for their high yield, drought tolerance, and adaptability to various climates and farming practices (Lou *et al*., 2006; Namutebi *et al*., 2013; Hua *et al*., 2015).

In contrast, the tetraploid Irish potato originates in the Andes and was introduced to Europe in the 16th century. By around 1590 CE, it had reached Ireland. Cultivated in Ireland's cool, humid climate, the Irish potato became a staple food by the 17th century.

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Since then, many genetic variants have been created to take local situations into consideration. With a production volume of 1284370 metric tons and an average yield of 3720 point 1 kg per hectare, Nigeria ranks fourth in sub-Saharan Africa for Irish potato production (FAOSTAT, 2012; FAOSTAT, 2015). The crop is still underutilized in Nigeria despite its potential to improve nutrition and food security (Schulte Geldermann 2013). The microbial diversity in potato-producing habitats has been the subject of numerous studies. Based on research conducted by Bulgarelli *et al*. (2012) as well as Mendes *et al*. (2014) the rhizosphere bacterial, fungal and other microorganism interactions are essential to plant health and nutrient cycling.

Numerous microorganisms can affect potatoes in the field and during storage, but fungi are the primary cause of deterioration. Field infection symptoms, such as internal cork or russet cracks, may appear after harvest, but most viruses have no effect on post-harvest quality. For the purpose of creating efficient disease control plans suited to particular conditions, identifying rotting organisms is crucial. Common fungi associated with potato rot and spoilage include *Ceratocystis fimbriata*, *Penicillium* species, *Fusarium solani*, *Monitochaetes infuscans*, *Macrophomina phaseolina*, *Botrytis cinerea*, *Diaporthe*, *Aspergillus niger*, *Aspergillus flavus*, *Fusarium oxysporum*, *Rhizopus stolonifer*, *Mucor pusillus* and *Erisiphe polygoni*. Specific studies have identified *Aspergillus fumigatus*, *Aspergillus niger*, and *Rhizopus stolonifer* as notable spoilage agents (Agu *et al*., 2015).

Potatoes naturally host various microorganisms on their skin and sprouts, which typically do not cause spoilage under normal conditions. Culture-dependent studies have isolated diverse bacteria from surface-sterilized potato peels and sprouts, indicating the presence of endophytes within the plant tissues. However, spoilage is accelerated in bruised potatoes, where physical damage allows microbial entry, or in those contaminated with high levels of spoilage microorganisms, leading to rot and rendering them unsafe for consumption.

Understanding the microorganisms associated with spoilage and developing strategies to prevent it are critical for extending the storage life of potatoes. This is particularly important in developing regions, where potatoes are a dietary staple. This study aims to identify the microorganisms associated with both Irish and sweet potatoes, contributing to improved storage practices and reduced spoilage, ultimately enhancing food security and nutrition.

II. Materials And Methods

A. Study area/Sources of samples

The study was conducted in the Microbiology laboratory various samples of Irish and sweet potatoes were obtained from the local market. The samples will be collected from local markets providing a representative sample of the microorganisms associated with these potatoes.

B. Collection of samples

A total of 42 samples were procured. Fifteen (21) Irish potatoes, and Fifteen (21) Sweet potatoes. The potatoes comprised healthy, bruised and spoiled samples of each variety and were randomly selected. They were bought from local vendors, at Choba and Mile One Markets in Port Harcourt Rivers State Nigeria,

C. Samples preparation

The stock solution was prepared by placing 25g of samples into a sterile stomacher bag then adding 225 ml of diluent/peptone water and then homogenize using a stomacher. Samples were serially diluted tenfold from 10^1 to 10^7 and then spread with a 0.1 ml inoculation onto plates of each media together with post Incubation; Mannitol salt agar (Merck) Nutrient agar (NA, Merck, USA), Potato dextrose agar (PDA, Merck), MacConkey agar (Merck)and plate count agar (PCA, Merck) were prepared according to manufacturer instructions. Colonies from the incubated agar plates were counted after 24 hours for bacteria and 72 hours for fungal count.

The cfu/g was determined using

Cfu/g = No of colonies x dilution factor / Volume of the culture plate.

D. Identification of isolates

- *Morphological identification of bacteria*: Bacterial isolates were characterized and identified using cultural, morphological, and microscopic characteristics. The macroscopic examination of the colonies included aspects such as size, color, pigmentation, surface texture, elevation, and margin. The macroscopic examination of the colonies included aspects such as size, color, pigmentation, surface texture, elevation, and margin. and biochemical tests were used to further identify the bacterial isolates following standard microbiological methods as described by Cheesbrough (2006).
- *Fungal identification*: The identification of fungal isolates followed established procedures incorporating macroscopic and microscopic features, adhering to the lacto-phenol (Cotton blue test) standard method. A clean slide was prepared by placing a single drop of methanol, and a segment of fungal growth was carefully excised using a surgical blade and tested in the methanol solution. Subsequently, a drop of lacto-phenol cotton blue was introduced. Gently placing a cover slip over the preparation, the slide was then observed under the microscope, utilizing X40 objectives for a detailed examination (Cheesbrough, 2006).

E. Physicochemical analysis

- *Proximate composition*: The determination of the moisture, protein, fat, carbohydrate, ash, and fiber contents of each variety of potato, according to the standard procedures of AOAC (2000) and as described by Ellong *et al*. (2014) and Aweke and Roba (2016).

F. Statistical analyses

Analysis of variance (ANOVA) was used to compare means at $p < 0.05$. The difference in the microbial count of healthy, bruised and spoilt Irish and sweet potatoes. using SPSS (Statistical Package for the Social Sciences), also known as IBM SPSS Statistics, is a software package used for the analysis of statistical data. Statistical significance was set at ($P<0.05$).

III. Results

A. Total heterotrophic bacteria count of the Irish potato

The total heterotrophic bacteria (THB) count from the Irish potato samples under investigation ranged from $3.25x10^5$ to $1.9x10^6$ CFU/g for healthy potatoes and from $5.7x10^5$ to $1.12x10^6$ CFU/g for bruised Irish potatoes. As seen in Figure 1, the THB count of the spoiled Irish potato samples under study ranged from $9.15x10^5$ to $1.71x10^6$CFU/g.

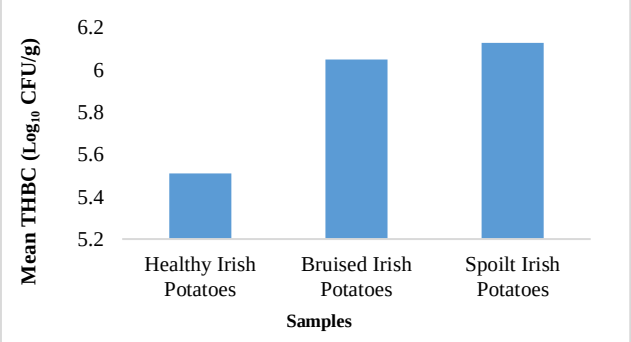

Figure 1. Total heterotrophic bacteria count of the Irish potato.

B. Total heterotrophic bacteria count of sweet potato

In the sweet potato samples under investigation, the total heterotrophic bacteria (THB) counts ranged from $4.15x10^5$ to 6.35x105 CFU/g for healthy potatoes and from 3.8x105 to 4.55x105 CFU/g for bruised sweet potatoes. As illustrated in Figure 2, the THB count of the spoiled sweet potato samples under investigation ranged from 1.49x106 to 2.24x106 CFU/g.

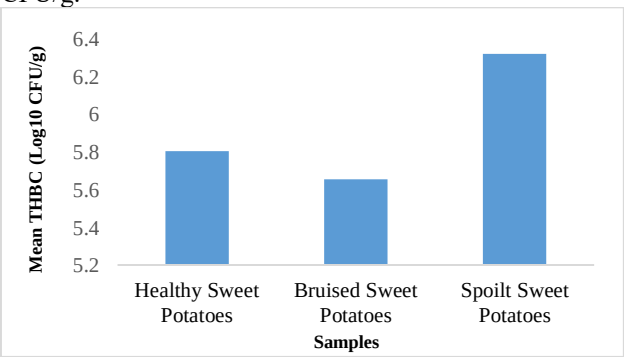

Figure 2. Total heterotrophic bacteria count of sweet potato.

C. Staphylococcus count of the Irish potato

Healthy Irish potatoes had staphylococcus levels between $1.45x10^4$ and $3.25x10^4$ CFU/g, but bruised Irish potatoes had numbers between $3.5x10^3$ and $6.7x10^4$ CFU/g, according to the staphylococcus counts recovered from the investigated samples. As seen in Figure 3, the count of the spoiled Irish potato samples under study ranged from $3.0x10^2$ to $9.15x10^4$ CFU/g.

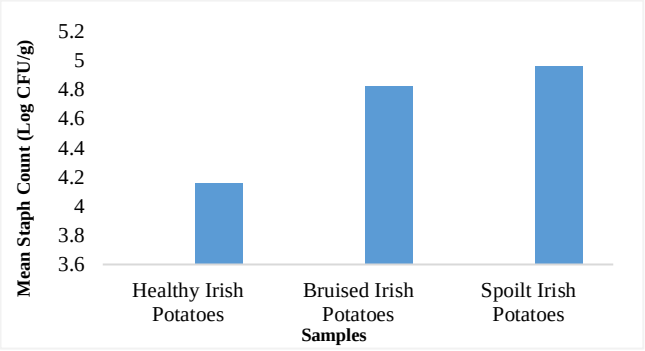

Figure 3. Total Staphylococcus counts of the Irish potato.

D. Staphylococcus count of sweet potato

The staphylococcus counts obtained from the sweet potato samples under investigation showed that the bruised sweet potatoes had counts ranging from $2.6x10^4$ to $5.35x10^4$ CFU/g, while the healthy potatoes had counts between $2.1x10^4$ and $3.7x10^4$ CFU/g. The number of spoiled sweet potato samples under investigation varied from $2.35x10^4$ to $6.3x10^4$ CFU/g, as illustrated in Figure 4.

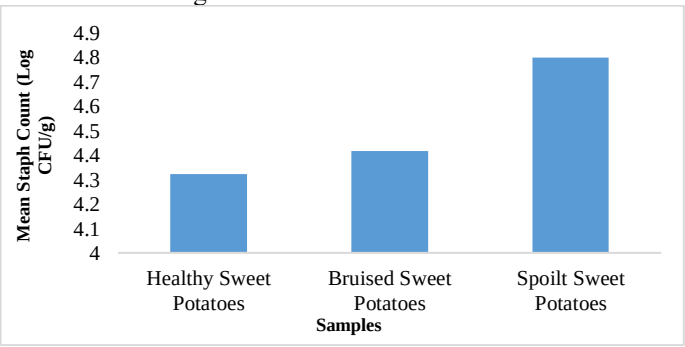

Figure 4. Total Staphylococcus counts of sweet potatoes.

E. Total coliform count of the Irish potato

The total coliform counts obtained from the Irish potatoes samples studied showed that the healthy potatoes had total coliform counts ranging from $3.25x10^2$ to $6.45x10^2$ CFU/g while the bruised Irish potatoes had counts ranging from $3.9x10^2$ to $6.85x10^3$ CFU/g. The spoilt Irish potato samples studied had counts ranging from $5.25x10^4$ to $7.8x10^5$ CFU/g (Figure 5).

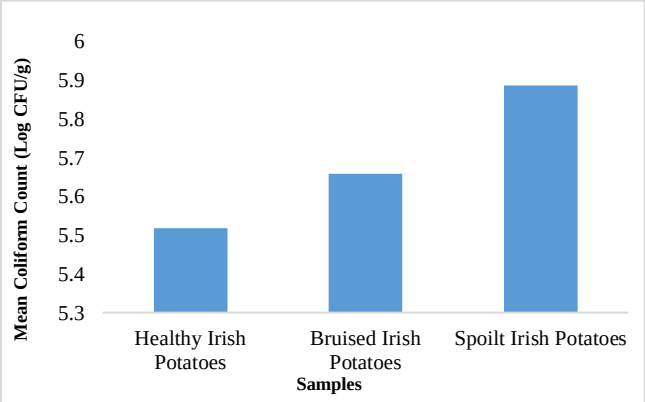

Figure 5. Total coliform counts of the Irish potato.

F. *Total coliform count of sweet potato*

The total coliform counts obtained from the sweet potatoes samples studied showed that the healthy potatoes had total coliform counts ranging from $2.1x10^2$ to $3.7x10^3$ CFU/g while the bruised sweet potatoes had counts ranging from $2.5x10^4$ to $5.35x10^4$ CFU/g. The spoilt sweet potato samples studied had counts ranging from $2.35x10^4$ to $6.3x10^5$ CFU/g (Figure 6).

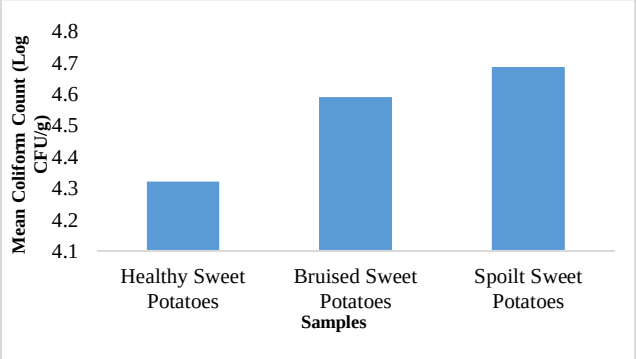

Figure 6. Total coliform counts of sweet potato.

G. *Total fungal Count of Irish Potato*

The total fungal counts obtained from the Irish potatoes' samples studied showed that the healthy potatoes had total fungal counts from $3.5x10^3$ to $1.65x10^4$ CFU/g while the bruised Irish potatoes had counts from $1.05x10^4$ to $6.7x10^4$ CFU/g. The spoilt Irish potato samples studied had counts ranging from 2.0x104 to 3.65x104 CFU/g (Figure 7).

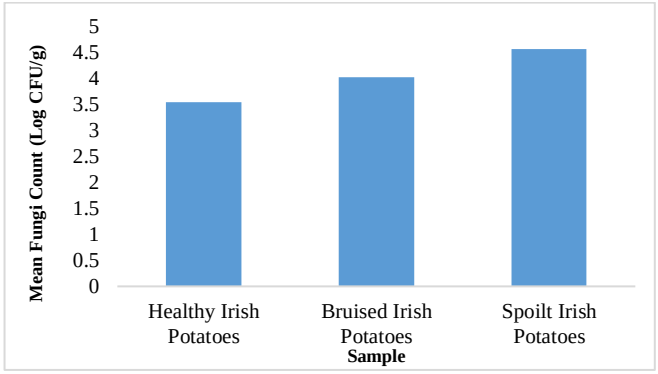

Figure 7. Total fungi count of the Irish potato.

H. *Total fungal Count of Sweet Potato*

The total fungal counts obtained from the sweet potatoes samples studied showed that the healthy potatoes had total fungal counts from $2.1x10^4$ to $3.7x10^4$ CFU/g while the bruised sweet potatoes had counts ranging from $2.5x10^4$ to $5.35x10^4$ CFU/g. The spoilt sweet potato samples studied had counts ranging from $2.35x10^4$ to $6.3x10^4$ CFU/g (Figure 8).

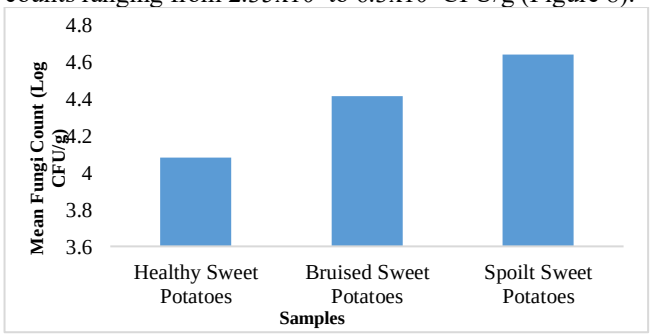

Figure 8. Total fungi count of sweet potato.

Table 1. Percentage occurrence of bacteria isolated from Irish and sweet potatoes studied

Bacteria genera	**Total N (%)**
Micrococcus spp.	3 (3.0)
Staphylococcus spp.	19 (20.4)
Bacillus spp.	19 (20.4)
Corynebacterium spp.	5 (5.4)
Escherichia coli	10 (10.6)
Klebsiella spp.	8 (8.6)
Pseudomonas spp.	8 (8.6)
Lactobacillus spp.	4 (4.3)
Enterobacter spp.	5 (5.4)
Citrobacter spp.	4 (4.3)
Proteus spp.	8 (8.6)
Total	93 (100)

I. Frequency of occurrence of bacteria isolated Irish and sweet potatoes studied

The frequencies obtained were *Proteus* spp. 8.9%; *Pseudomonas* spp. 8.6% *Citrobacter* 4.3%; *Corynebacterium* 5.4%; *Enterobacter* spp. 5.4%; *Lactobacillus* spp. 4.3% and *Micrococcus* spp. 3.0% *Staphylococcus* spp. 20.4%; *Bacillus* spp. 20.4%; *Escherichia coli* 10.6%; *Klebsiella* spp. 8.6%; (Table 1).

The frequency of occurrence of the fungal species: *Fusarium* 18.4%; Pink Yeast 6.1%; *Aspergillus flavus* 4.1%; Yeast 26.5%; *Aspergillus niger* 20.4%; *Mucor* 20.4%; *Rhizopus stolonifera* 2.0% and *Trichoderma* 2.0% as shown in Table 2.

Table 2 Percentage occurrence of fungi isolated from Irish and sweet potatoes studied

Fungi Identity	**Total N (%)**
Aspergillus niger	10 (20.4)
Aspergillus flavus	2 (4.1)
Fusarium spp.	9 (18.4)
Yeast	13 (26.5)
Pink Yeast	3 (6.1)
Rhizopus stolonifer	1 (2.0)
Mucor spp.	10 (20.4)
Trichoderma spp.	1 (2.0)
Total	49 (100)

J. Proximate Composition of Irish and Sweet Potatoes Studied

Sweet and Irish Potatoes had varying proximate compositions as seen in Table 3

Table 3. Proximate Composition of Irish and Sweet Potatoes

S/N	Sample Identity	Cho (%)	Moisture content (%)	Fibre (%)	Ash (%)	Crude Protein (%)	Crude Lipid (%)
1	Healthy Sweet Potato	35.52	52.49	1.92	2.53	7.28	0.17
2	Bruised Sweet Potato	35.52	52.49	1.92	3.18	5.94	0.28
3	Healthy Irish Potato	30.86	59.95	2.67	1.97	3.82	0.19
4	Bruised Irish Potato	32.14	58.92	3.22	1.68	3.11	0.23

IV. DISCUSSION

A. Microbial quality of healthy, bruised, and spoilt Irish and Sweet Potato

The study examining the microbial quality of healthy, bruised, and spoiled Irish and sweet potatoes reveals clear variations in total heterotrophic bacteria (THB) counts across the different samples, as illustrated in Figures 1 and 2, which show the mean Log10 cfu/g THB. For Irish potatoes, the THB counts in healthy samples were relatively lower from 3.25×10^5 to 1.9×10^6 CFU/g. In contrast, bruised potatoes exhibited slightly higher counts, from 5.7×10^5 to 1.12×10^6 CFU/g. THB counts in spoiled Irish potatoes increased significantly ($P < 0.05$) ranging from $9.\ 15 \times 10^5$ to $1.\ 71 \times 10^6$ CFU/g suggesting significant microbial proliferation during spoiling. On the other hand, healthy sweet potatoes had THB counts that ranged from $4.\ 15 \times 10^5$ to $6.\ 35 \times 10^5$ CFU/g which were like those of healthy Irish potatoes. Compared to bruised Irish potatoes the THB counts of bruised sweet potatoes were marginally lower from $3.\ 8 \times 10^5$ to $4.\ 55 \times 10^5$ CFU/g. The spoiled sweet potatoes had the highest THB counts from $1.\ 49 \times 10^6$ to $2.\ 24 \times 10^6$ CFU/g. ($P < 0.05$), indicating significant microbial growth during spoiling, like that seen in spoiled Irish potatoes. Amah *et al*. (2020) reported a total aerobic bacterial count of 2.3×10^6 cfu/g for sweet potatoes, and Oduola *et al*. (2018) reported that the total aerobic bacterial count in sweet potatoes was 2.3×10^6 cfu/g.

Figures 3 and 4 show the Staphylococcus counts in healthy, bruised, and spoiled Irish and sweet potatoes. Staphylococcus counts for Irish potatoes ranged from 1.45×10^4 to 3.25×10^4 CFU/g in healthy samples, while the bruised potatoes ranged from 3.5×10^3 to 6.7×10^4 CFU/g

Indicating a mixed microbial population during the spoiling process the counts of spoiled Irish potatoes varied from $3.\ 0 \times 10^2$ to $9.\ 15 \times 10^4$ CFU/g. Healthy sweet potatoes and healthy Irish potatoes had comparable staphylococcus counts which ranged from 2.1×10^4 to 3.7×10^4 CFU/g. A slightly wider range from 2.6×10^4 to $5.\ 35 \times 10^4$ CFU/g was observed for bruised sweet potatoes indicating that bruising might have led to an increase in Staphylococcus counts. Interestingly spoiled sweet potatoes had relatively stable Staphylococcus counts ranging from $2.\ 35 \times 10^4$ to $6.\ 3 \times 10^4$ CFU/g in contrast to spoiled Irish potatoes, particularly potatoes bought from outdoor markets without adequate hand-washing facilities had Staphylococcus sp. counts ranging from 2 to 6 log CFU/g (Bryan *et al*., 1992).

Buyers often inspect these potatoes to check their firmness before buying them. Post-harvest potatoes that contain Staphylococcus species may indicate poor handling, storage, or harvesting practices, which can reduce the potato's overall quality and result in rotting or a reduced shelf life. Maintaining potato quality and ensuring food safety requires addressing these sanitary issues.

Staphylococcus species can cause potatoes to spoil, giving them bad tastes, disagreeable smells, and texture changes such changes can negatively impact consumer perceptions, potentially reducing marketability and increasing waste.

In the study investigating the microorganisms associated with healthy, bruised, and spoiled Irish and sweet potatoes, total coliform counts exhibited variations across different conditions, as depicted in Figures 5 and 6, which show the mean Log10 cfu/g. For Irish potatoes, healthy samples recorded total coliform counts from 3.25×10^5 to 6.45×10^5 CFU/g. Bruised potatoes demonstrated similar counts from 3.9×10^5 to 6.85×10^5 CFU/g. Spoiled Irish potatoes showed

an increase in counts from 5.25×10^5 to 7.8×10^5 CFU/g, indicating a potential rise in coliform populations during spoilage. In contrast, healthy sweet potatoes had lower total coliform counts, ranging from 2.1×10^2 to 3.7×10^3 CFU/g, compared to healthy Irish potatoes. Bruised sweet potatoes also exhibited lower counts, from 2.5×10^4 to 5.35×10^4 CFU/g. Spoiled sweet potatoes had counts from 2.35×10^4 to 6.3×10^4 CFU/g. Overall, the total coliform counts suggest that while Irish potatoes exhibited higher counts across conditions compared to sweet potatoes ($P<0.05$), the trends in coliform populations remained relatively consistent, with observable increases during spoilage in both types of potatoes. Coliforms are widely recognized as bacterial indicators of the sanitary quality of foods and water and are commonly associated with microbial pollution; they are found in animal and human intestines (Tortora, 1995). Our findings align with those of Tambekar and Mundhada (2006), who reported various food-borne bacterial pathogens found in fresh vegetables and potatoes.

While the presence of coliform bacteria in post-harvest potatoes is not generally considered a major food safety concern given that these bacteria are typically found in the environment, including soil and water, it should not be entirely overlooked. Their presence may signal poor hygiene practices during harvesting, storage, or handling. Although coliform bacteria themselves are not usually pathogenic, their detection may indicate the possible presence of other spoilage microorganisms that can affect potato quality and shelf life. Additionally, coliform bacteria can indicate potential fecal contamination from animals or humans. While they are not harmful by themselves, their presence may suggest that other pathogenic bacteria or viruses could also be present, posing a risk to human health if consumed.

Total fungal counts revealed significant differences across the various conditions, as illustrated in Figures 7 and 8, indicating the mean Log10 cfu/g. Healthy Irish potatoes displayed total fungal counts from 3.5×10^3 to 1.65×10^4 CFU/g, while bruised potatoes exhibited wider counts from 1.05×10^4 to 6.7×10^4 CFU/g. Spoiled Irish potatoes showed counts from 2.0×10^4 to 3.65×10^4 CFU/g, indicating a potential increase in fungal populations during spoilage. Conversely, healthy sweet potatoes demonstrated higher fungal counts, ranging from 2.1×10^4 to 3.7×10^4 CFU/g, compared to healthy Irish potatoes ($P<0.05$). Bruised sweet potatoes displayed counts from 2.5×10^4 to 5.35×10^4 CFU/g, similar to those of Irish potatoes. Spoiled sweet potatoes had counts from 2.35×10^4 to 6.3×10^4 CFU/g.

These findings contrast with Oduola *et al*. (2018), which reported fungal counts ranging from 1.80×10^7 cfu/g to 2.90×10^7 cfu/g, and are somewhat similar to Amah *et al*. (2020), which noted fungal counts from 0.8×10^5 cfu/g to 1.4×10^5 cfu/g. Our results align with those of Agu *et al*. (2015), who noted that fungi such as *Aspergillus, Penicillium*, and *Fusarium* species can cause decay in potatoes after harvest.

This deterioration can affect the quality and marketability of potatoes by reducing shelf life, causing spoiling, and generating waste. During the growth season, fungi such as black scurf, late blight, and early blight can also cause fungal infections that reduce yields and quality, potentially resulting in crop loss. When consumed by humans or animals, mycotoxins produced by some fungi, such as Aspergillus and Fusarium species, can be harmful. Acute poisoning and chronic illnesses are just two of the health problems that mycotoxins can cause.

The study on microorganisms associated with healthy, bruised, and spoiled Irish and sweet potatoes involved morphological and biochemical characterization of bacterial and fungal isolates. Eleven genera of bacteria were identified, including *Escherichia coli, Klebsiella, Pseudomonas Staphylococcus, Micrococcus, Bacillus, Corynebacterium, Lactobacillus, Enterobacter, Citrobacter*, and *Proteus.* Among the bacterial isolates, *Staphylococcus* and *Bacillus* were the most prevalent, each occurring at a frequency of 20.4%. *Escherichia coli, Klebsiella, Proteus,* and *Pseudomonas* were also identified, albeit at lower frequencies ranging from 8.6% to 10.6%. Fungal isolates include *Trichoderma* spp.*, Aspergillus fumigatus, Penicillium* spp. *Mucor* spp.*, Aspergillus flavus, Aspergillus niger, Rhizopus stolonifer, Yeast, Pink Yeast and Fusarium* spp. Different fungi had different frequencies of occurrence the most prevalent was yeast (26.5%) followed by *Aspergillus niger* and Mucor (20.4%). Although other fungi like Pink Yeast, *Aspergillus flavus Rhizopus stolonifera* and *Trichoderma* were present at lower frequencies ranging from 2. 0% to 6. 1%. Fusarium was also occurring at 18. 4 %.

Scientists have also documented microorganisms that have been identified as being responsible for the spoilage of sweet potato during storage (Khatoon *et al*., 2016; Agu *et al*., 2015).

Oladoye *et al*., (2013) identified some of the bacteria that cause spoilage of potatoes to include *Staphylococcus*, *Bacillus, Pseudomonas*, all of which have the capabilities to produce enzymes that are capable of degrading sweet potato tissues. The fungi isolated and found responsible for its spoilage include *Aspergillus, Fusarium, and Geotrichum*. Agu *et al*., (2015) Khatoon *et al*., (2016);.

The high percentage incidence of *Aspergillus niger* in this study is comparable to the findings of Tortoe *et al*. (2010), who reported that *Aspergillus niger* and *Aspergillus flavus* were the most prevalent fungus species on sweet potatoes. However, the microbial colonization of the harvested tubers must have been aided by some of the harvest defects that caused the tubers to bruise. The degraded microorganisms must have come from the soil because the tubers came into touch with it and the soil particles carried quantities of pathogens. It is known that both pathogenic and non-pathogenic microorganisms can be found in soil.

Potatoes have been known to have thin, soft skin that's easily destroyed by cuts and bruises during harvesting, transportation or distribution, it is important to reduce this to prevent outer damage to the tuber and thereby minimize microbial attack Rupsa *et al*., (2017). Low temperatures and high relative moisture in the post-crop terrain have been

known to affect the exertion of spoilage organisms (Sholberg *et al*., 2001). Besides good handling practice and transportation practices, potato tubers should be kept in an area that discourages the proliferation of organisms, especially molds. Potatoes are still a significant crop for numerous countries, and it's hereby suggested that necessary action should be taken towards the reduction of post-crop destruction.

B. Proximate composition of Irish and sweet potatoes

Sweet and Irish potatoes are important plants that play important roles in ensuring food availability and security. They are rich in starch and have been also reported to contain minerals and phytochemicals. The carbohydrate content was relatively consistent between healthy and bruised sweet potatoes, both at 35.52%, while healthy and bruised Irish potatoes exhibited slightly lower carbohydrate levels at 30.86% and 32.14%, respectively. The value for carbohydrate content differs among sweet and Irish potatoes and this variation could be linked to genotypic differences among the varieties. The carbohydrate content of 20.33±0.01 and 34.39±0.02% obtained for Irish and sweet potatoes respectively were reported by Wekhe *et al*., (2023) and these values are slightly lower than this present study. The values obtained in this study were slightly higher than that reported by Tsikrik *et al*., (2019) and Jin *et al*., (2016) who presented a result of 16.04 -23.06 and 15.14 -16.07g/100g respectively. Carbohydrates are the main macronutrient in potatoes with starch being predominant. Abbasi *et al*., (2019). It is widely acknowledged that foods with carbohydrates are rapidly digested and quickly release glucose into the bloodstream and typically have a high glycemic index. Conversely, foods containing carbohydrates can break down more slowly, resulting in a gradual release of glucose, and generally have a reduced glycemic index (Jenkins *et al*., 1981). Further research is needed to explore the types of carbohydrates present in local varieties and their impact on blood glucose levels, which will enhance our understanding of the potential role of sweet potatoes in diabetes management.

Moisture content was similar between healthy and bruised sweet potatoes, recorded at 52.49%, while healthy and bruised Irish potatoes had slightly higher moisture content at 58.95% and 58.92%, respectively. This present study is lower than the moisture content obtained for Irish and sweet potatoes which is 70.57±0.06 and 54.67±0.58% respectively reported by Wekhe *et al*., (2023). The high moisture content value recorded in this study could be attributed to inherent differences in the varieties. As Motalebifard *et al*., (2013) have indicated, when potatoes are cultivated in dry soil, the dry matter percentage of the Iran cultivar tends to increase dramatically as indicated by a lack of surplus soil moisture. Commenting further on the above, Cruz *et al*., (2018) observed that a low moisture content in potato tubers is desirable as the water content and dry matter percentage are inversely related. For instance, low moisture content means minimal water which is directly associated with a high dry matter content, which results in food products such as potato chips, or French fries, having a better crispiness and texture. The cooking time is reduced due to less water content in the food that needs to evaporate, which means less oil is required in the deep-frying process. Lower oil absorption promotes a better end product, enhances product including mashed potatoes' cooking processes, and improves their productivity and profitability.

Fiber content showed minor variations, with both healthy and bruised sweet potatoes having 1.92%, healthy Irish potatoes had 1.97% fiber and bruised Irish potatoes having a higher fiber content of 3.22%. The crude fibre content of Irish and sweet potatoes (1.23±0.06 and 1.33±0.01%) reported by Wekhe *et al*., (2023) was slightly higher than this present study and lower than that reported by Garcia *et al*., (2015) who reported values of 0.61 -0.66mg/100g. The values obtained are comparable to those presented by Rose and Vasanthakaalam (2011), exceeding the figures from Ukom *et al*. (2009) in Nigeria, yet falling short of the 3.30 to 5.40% range noted by Ellong *et al*. (2014) in Martinique. Trinidad *et al*. (2013) highlights the significance of dietary fibers in preventing cardiovascular diseases and diabetes mellitus, as well as their effectiveness in reducing the incidence of colon cancer and certain digestive disorders, as noted by Rose and Vasanthakaalam (2011). Generally, the fiber content in potatoes is lower than that found in other vegetables and root crops; however, it is noteworthy that processed potato products, such as potato flakes and French fries, have been shown to contain a higher concentration of crude fiber (Tsikrik *et al*., 2019).

Ash content was similar between healthy and bruised sweet potatoes, recorded at 2.53% and 3.18%, respectively, while healthy and bruised Irish potatoes exhibited slightly higher ash content at 2.67% and 3.22%, respectively. Total ash content values reported in this study differ among sweet and Irish potatoes but are slightly similar to the values reported by Wekhe *et al*., (2023) which is 2.33±0.06 for sweet potatoes and 1.43±0.06 for Irish potatoes. the findings of Jin *et al*., (2016) who reported total ash content in the range of 0.87 - 1.04g/100g in four Korean potato varieties and Sato *et al*., (2017) in Japanese varieties respectively is lower than the values obtained in this present study.

Crude lipid content was relatively low across all samples, with bruised sweet potatoes having the highest at 0.28%, followed by bruised Irish potatoes at 0.23%, healthy Irish potatoes at 0.19%, and healthy sweet potatoes at 0.17% was slightly lower than that reported by Wekhe *et al*., (2023) which was 0.74±0.02 for Irish potatoes and 0.50±0.00 and range of 0.03 and 0.06g/100g reported by Sato *et al*., (2017) in 4 Japanese potato varieties. Lipids play a crucial role in food substances, as they are essential for the functioning of the cells, while also significantly contributing to the energy value of foods (Eleazu and Ironua, 2013). Although potatoes have a low fat content, this may not have a major nutritional impact; however, lipids are important for enhancing the sensory qualities of cooked tubers and for maintaining

cellular integrity, which helps resist bruising in the tubers (Kalita and Jayanty, 2017).

Crude protein content varied across the potato samples, with healthy sweet potatoes having the highest at 7.28%, followed by bruised sweet potatoes at 5.94%, healthy Irish potatoes at 3.82%, and bruised Irish potatoes at 3.11%. this is slightly lower than the values presented by Wekne *et al*., (2023) which is 6.44±0.06 and 5.73±0.01 for sweet and Irish potato respectively. This present study was higher than that obtained for Polish potato variety (0.913g/100g) reported by Wszelaczynska *et al*. (2020), Rose and Vasanthakaalam (2011), Eleazu and Ironua, (2013) and Jin *et al*., (2016).

The proximate composition values found in this study are similar to the range that Sato *et al*. (2017) and Tsikrika *et al*. (2019). These results suggest that the nutritional composition of healthy and bruised sweet potatoes varies somewhat with Irish potatoes exhibiting slight variations in moisture fiber and ash content. Additionally, the different protein and lipid contents of the potato samples might affect their overall nutritional value and susceptibility to spoiling and microbial colonization.

V. Conclusion

These findings demonstrate the importance of understanding the nutritional composition and microbial dynamics of potatoes at different stages of deterioration. This information may aid in the development of improved handling and storage methods that maintain nutritional value and minimize spoiling.

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