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Identification Of Phytochemical Properties of Irish Potato (*Solanum Tuberosum*) Peels and Its Predominant Spoilage Fungi

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Abstracts

Potato tubers have a significant role in Universal food security as they are pivotal basis of carbohydrates essential for human nutrition. The research was conducted to evaluate the phytochemical and physicochemical elements of methanolic extract in Irish potato (*Solanum tuberosum*) peels and also to isolate and determine the fungal species causing spoilage of Irish potato spoilage obtained from Yakuba and Rimi markets, Kano State. The determination of moisture and ash of the potato peels was carried out using modified Association of Official Analytical Chemists (AOAC) methodology. The results of phytochemical assessment of the potato peels showed alkaloids, carbohydrates, flavonoids, protein, saponins, phenols and tannins existence. Physicochemical evaluation of the dried powdered peel showed moisture content (13.05%), ash value (10.60%), and extractive value (6.66%). The diseased potatoes were assessed using standard serial dilution method and inoculation on Potato Dextrose Agar (PDA), and identification was done morphologically using physical characteristics like color, texture, shape and size; conidia; hyphae; conidiophore; spore formation and pigmentation. The assessment showed *Aspergillus spa* (38.9%), *Fusarium spa* (16.7%), *Rhizopus spa* (11.1%), *Penicillium spa* (11.1%), *Alternaria spa* (5.5%) and *Mucor spa* (16.7%) as the most predominant spoilage fungi associated with Irish potatoes. The screened components of the peel have therapeutic potentials while the fungal isolates are responsible for potatoes tuber deterioration posing food insecurity, economic losses and environmental impacts.

Key words: *Irish potato, phytochemical, physicochemical, spoilage fungi.*

INTRODUCTION

Irish Potato's (*Solanum tuberosum* L.) is among the nightshade family (*Solanaceae)* grown for its starchy edible tubers and hence among the vital agricultural produce [12]. Being the world's fourth largest food crop following corn, wheat and rice, Potato constitute of compounds which are beneficial to human health.

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[8]. It was known four centuries ago outside the Andes as the necessary component in some of the world's cuisines [25]. This tuber crop possesses essential amino acids, vitamins and minerals which has an essential role in human diet. [18]. Potato's peels are often lost during processing and production as potato peel waste [3] As a rich source of dietary fiber, primarily consisting of insoluble carbohydrates, cellulose, hemicellulose, lignin, pectin and gums (Al-washday and Rao, 2012). Phenolic compounds such as hydroxycinnamic acid derivatives and flavonoids were reported to be present in great quantity in potato and almost 50% of phenolics are found in the peel and adjacent tissues (Ablashi *et al*., 2013); and[7]. Due to spoilage rate of fresh potatoes, Universal usage of potatoes is upgrading fresh storage to processing by grounding, mashing, preserving and canning, also by frying to make chips [16] Potato peels are being generated by the potato processing industries worldwide (around 70-140 thousand tones statistically) as zero-value waste materials. Potato waste has posed environmental degradation consequences and costs implication in management. Holistic and environmentally friendly approach to the reuse or disposal of this waste is essential for food processing industries [6]. Various studies highlight the importance of potato peels as a provider of natural antioxidants [16] However, recent research indicates that synthetic antioxidants may have harmful effects on human health, prompting increased interest by food scientists in discovering natural alternatives [9] Resultantly, these active ingredients can be incorporated into foods as a source of phytonutrients or to create nutraceuticals due to their potential health benefits (Ablashi *et al*., 2013)

Attributed to its nutrient and water contents, Potato needs a require a temperature of $15^{o}C - 20^{o}C$. It is highly prone to microbial attack, particularly when the skin is physically abraded or damaged during harvesting or transportation [19] Post-harvest decays of fruits vegetables and tubers leads to substantial losses, with an estimated 20-25% of the produce harvested being spoiled by pathogens during storage, even in advanced nations (El-Gout *et al*., 2004; [14]. Food spoilage is often more severe due to inappropriate storage method and transportation facilities in developing nations. Synthetic fungicides are employed to manage postharvest diseases of fruit, vegetable and tubers (El-Gout *et al*., 2004; [14] Studies conducted by various researchers clearly indicate that the primary cause of tuber spoilage during shipment or storage is high temperature and damage sustained during marketing and transport [22] Several factors contribute to spoilage which can be categorized as intrinsic and extrinsic factors. Intrinsic factors are internal properties inherent to the food itself that influence its deterioration, while extrinsic factors are environmental external conditions that affects the foods spoilage. The requirement for time/temperature control is primarily dictated by the risk for contamination with pathogens and the potential for subsequent growth and toxin production [26] Water is a required medium for the proliferation of microorganisms whether fungi or bacteria in food products. Regulating water content in foods is one of the most utilized preservation strategies (Jay, 2000).

METHODOLOGY

Sampling and Preparation of Potato Tubers

The Irish potato tuber samples of Nicola variety were obtained from Yakuba and Rimi markets Kano State. Freshly harvested potato tubers were cleaned with water and peeled with a sharp knife. It was air dried and pulverized into powdered form using mortar and pestle and stored in air tight container

Extraction of Potato Peel

The sample weighing sixty (60) grams was measured and macerated in 300ml of 70% methanol for 48 hours. The solution was filtered through section vacuum filter. The extract was filtered through section vacuum filter. The extract was then evaporated under water bath.

Phytochemical Screening

The extract was utilized to screen alkaloids, saponin, phenol and tannins, carbohydrates, flavonoids, and proteins as bioactive compounds using the standard procedure as described by [4].

Carbohydrate Test

Two (2mls) of potato peels distillate sample were pipetted into a test tube, followed by the addition of two drops of alcoholic naphthol solution, which was then vigorously shaken. Subsequently, a few drops of concentrated sulphury acid were slowly introduced into the test tube. A violent ring indicated the presence of carbohydrates (Trease and Evans 1983)

Test for Flavonoids

Five (5mls) of diluted ammonia solution and one ml of concentrated H_2SO_4 acid were added to a portion of the aqueous filtrate from potato peels extract. The presence of yellow coloration in the extract indicated the presence of flavonoid.

Test for Alkaloid

A volume of one (1ml) of the potato peel extract was combined with Mayer's reagent and drops of iodine solution were also introduced. The appearance of a yellow color signaled the presence of alkaloids

Phenolic Compound

The peel extract was added into 5ml of distilled water, followed by the addition of few drops of

A neutral 5% of chloride solution. The development of a dark green color signaled the presence of phenolic compound [24].

Test for Tannin

One (1ml) of the peel extract was dissolved into 1ml of 2% of $FeCl_3$. The formation of blue-green color indicated the presence of tannin.

Test for Saponin

A mixture containing 0.2g of the peel extract and 2.0ml of water was added to a test tube and vigorously shaken. The formation of a persisting foam that lasted for 10 minutes indicates the presence of saponin.

Test for Protein

A few drops of concentrated nitric acid were introduced to 1ml of the peel extract. The emergence of a yellow color signifies the presence of protein.

Physic-Chemical Parameters Analysis

The moisture and ash content of the potato peels were analyzed using modified of Association of Official Analytical Chemists [33] methods.

Determination of Moisture Content of Irish Potato (*Solanum Tuberosum*) Peel

The crucibles were air dried in an oven at 105^{o}C for 10mins, cooled inside a desiccator and weighed as (W_1). Two (2grams) of the samples were accurately weighed (W_2). The crucible containing the samples was then placed in the oven and dried at a temperature of 100^{o}C for 5 hours until a constant weight (W_3) was achieved. The percentage (%) moisture content was calculated by adopting the formula below:

Where:

W_1=2g

W_2=1.741g

$$\% \text{ Moisture content} = \frac{1.741}{2g} \times 100$$

=13.05%

Determination of Ash Content of Irish Potato (*Solanum Tuberosum*) Peel

The [33] method was adopted, the crucible was dried in air oven at 100^{o}C for 10mins and weighed (W_1) after cooled in a desiccator. Two (2g) of the prepared sample were accurately weighed (W_2) into a separate crucible and then proper aching was done using a muffle furnace at a temperature of about 550^{o}C for 8 hours. The crucibles with the ash content were removed and cooled inside the desiccator and weighed as (W3). The percentage of ash content was then calculated using the formular below:

Were,
W1=147.311g
W2= 149.311g
W3=147.523g

$$\% \text{ Ash} = \frac{147.523 - 147.311}{149.311 - 147.311} \times 100$$

$$= \frac{0.2121}{2.00} \times 100$$

=10.605%

Determination of Extractive value of Irish potato peel (*Solanum tuberosum*)

The cold maceration technique was adopted. Three conical flasks were cleaned and dried in an oven, 2g of the crushed samples were weighed and transferred into the conical flask. A homogeneous mixture was

achieved by swirling the mixture for 2 hours and weighed, then the mixture was filtered and the filtrate were weighed. The extractive yield was calculated using the formular below:

Where:
W_1= 104g
W_2=108g
W_0= 60g

$$\% \text{ (W/W) Extractive yield} = \frac{108 - 104}{60g} \times 100$$

= 6.66%

Identification and Sampling of Diseased Potatoes

Various types of Irish potatoes with spoilage symptoms were selected at random from Yakuba and Rimi market centers in Kano, Nigeria. The diseased potato samples such as those with grey –brown lesions, sunken and shriveled, grey brown lesions, purplish-brown rot and those that exude liquid and olive brown to black powdery masses of spores, were identified physically adopting the methods of [5]. The tubers were stored in sterile polythene bags and carried to Bayer University Kano (latitude 11°58′35″N and Longitude 8°28′41″ E) for further mycological analysis at the laboratory of microbiology.

Isolation and Identification of Fungi Associated with Rotting Irish Potatoes

The diseased tubers of Irish potato were rinsed under a running water and wiped using soaked cotton wool in 70% alcohol. the tubers were sliced with a sterile scapple starting from the unrotten portions. A cut of 5 x 5mm pieces was dip into a sterile distilled water, placed on Saburou Dextrose Agar (SDA) plate and incubated at room temperature for 5 days [13]. Identified types of colonies were purified and sub-cultured on fresh SDA plates. Pure colonies obtained were then isolated and inoculated into slants of SDA and identified. The fungal identification was done based on their colonial characteristics on culture plates. Using a sterile inoculating needle a portion of each mycelium was aseptically picked and placed on a clean microscope slide with addition of a drop of lactose phenol cotton blue. Microscopic identification was achieved by reference to [13] and identification atlas [30].

Test for Pathogenicity:

Non rotten tubers of Irish potato were rinsed and surface sterilized with 70% ethanol. Hollow cores were made in the tubers with 5mm sterilized corn borer. Four-millimeter (4mm) agar discs cultured for 7 days with the isolates were placed into the cores and then closed with the sterile Vaseline. A set of controls were inoculated with plain savored Agar blocks in their perforated cores. All the tubers treated were stored inside a sterile polythene bag and incubated at 28 ± 2°C for 10 days after which the tubers were sliced and examined for any sign of rot after incubation period (Abueli*ta*., 2008)

Results

Below showed result tables.

Tables 1 is the phytochemicals identified after extraction of *Solanum tuberosum* peels which showed the presence and absence of some secondary metabolites (phytochemical constituents). Alkaloids, Carbohydrates, Flavonoids, Protein, Phenols, Saponins and Tannin respectively as shown below.

Table 2 shows the physicochemical parameters of potato peels, estimating the percentage of moisture content, total ash and extractive value.

Table 3 shows the colonial and microscopic characteristic of fungal isolate with percentage frequency from the potatoes.

Table 4 shows types of spoilage that occur after pathogenicity test using healthy tubers.

Table 1: Phytochemical properties detected from methanolic extract of Irish potato peel.

S/N	Test	Observation	Inference
1	Alkaloid	Yellow coloration	+
2	Flavonoids	Light yellow	+
3	Carbohydrate	Violent red color	+
4	Phenolic compounds	Dark green color	+
5	Saponin	Appearance of foams	+
6	Protein	Appearance of yellow coloration	+
7	Tannin	No color change	-

Keys: + Indicates present. – Indicates absence

Physicochemical properties of Irish potato peels

Table 2:

S/N	Physicochemical properties	Value in percentage (%)
1	Moisture content	13.05%
2	Total ash	10.60%
3	Extractive Value	6.66%

Table 3: shows the colonial and microscopic characteristic of fungal isolate with percentage frequency from the potatoes.

S/N	Colonial Appearance	Microscopic characteristics	organism identified	% frequency

1	White wholly mycelium Spreading rapidly Underside Pinkish-red.	Septate branching hype, Fusarium *spa* conidia is sickled-shape		16.7%
2	White to yellow underside: cream conidiospores	Septate hyphae, conidia round and smooth with	*Aspergillus flavus*	5.5%
3	Exhibit many colors Particularly whitish, Conidia with brushlike heads Bluish-green and yellow, bearing spores. underside: creamy-yellow	septate hyphae and branched.	*Penicillium spa*	11.1%
4	Black colony underside: Black.	Conidia-raised upright terminating in globose with chain radiating	*Aspergillus spa*	33.3%
5	White to olive green Colony.	Septate hyphae conidia borne In chain at tip of conidiophore	*Alternaria spa*	5.5%
6	Large colony initially White and later turn Brown-black.	non-septate hyphae produce cluster of rootlike structures Rhizoids	*Rhizopus spa*	11.1%
7	Brownish chocolate Outside the hyphae. Chlamydospore With internal spore like structure Bearing Sporangia.	non-septate round granules	*Mucor spa*	16.7%

Table 4: Types of spoilage that occur after re-infecting healthy tubers

Organism	**Fungal growth**	**Types of spoilage on potato**

Aspergillus spa	+	Produce a slightly brown soft rot
Fusarium spa	+	Dry rot, surface of site of inoculation turns brownish-Black with hollow in the tuber.
Penicillium spa	+	No external tuber symptoms but when cut, light brown Discoloration was seen**.**
Rhizopus spa	-	No visible spoilage observed
Alternaria spa	-	No visible spoilage observed
Mucor spa	+	Dry rot, surface of site of inoculation turns brownish-Black with bigger hollow in the tuber.

Key: + positive

- negative

Discussion

The phytochemical evaluation of *Solanum tuberosum* peel showed the presence and absence of some phytochemical constituents such as alkaloids, carbohydrates, flavonoids, protein, phenols, saponins and tannin which are recorded by researchers to exhibit medicinal and physiological properties. This was also reported by [31]. High contents of tannin (0.55), alkaloids (2.17), saponin (4.00), flavonoids (5.00) and phenol (2.00) reported by [21] Irish potato during his comparative analysis with yellow yam and sweet potato also align with the findings in this study.

[17] reported that Potato peel is rich in phenolic compound with multiple biological functions. In their research; the antimicrobial efficiency of the peel and its antioxidant potential incorporated with potato starch film" investigated, they concluded that potato peel extract has antibacterial and antioxidant property which may serves as an alternative technology for active food packaging and preservation.

[29] also recorded phytochemicals such as alkaloids, saponins, flavonoids, Tannins, phenolic compounds, carbohydrates and protein in accordance with the result obtained in this study and concluded that they have medicinal and healing properties such as those found in herbs which depend on their solubility in various solvent.

In a review article overview by [20] where they evaluated the phenolic compounds in Irish potato and its products, the effects of harvesting, post-harvest, and technological processes". The phenolic compounds identified were found to be responsible in synthesizing the potato plant with a protective response against

bacteria, fungi, viruses, and insects. Furthermore, several researches showed that these potato peel extracted compounds have health-promoting effects in humans. However, different processing methods used for these potatoes in the food industry subjects them in altering the phenolic content as many of these compounds with high bioactivity are enclosed in the potato peel, and so are mostly eliminated as waste.

Lakhe and Dabekar, (2018) in their study of the value of potato peel observed that the peels of potato is generally removed after boiling and thrown out by consumers as it is considered as waste material. During their study, potato peels were collected and subjected to extraction process and they found out that it is rich in antioxidant, antibacterial components. It contains fiber, minerals (iron, zinc, potassium, and calcium), including vitamin (B & C), starch, phenol, etc. Therefore, they suggested incorporating potato peel extract in various cosmetic products to enhance it activity.

The isolation and identification of spoilage fungi in Irish potato in this study, revealed the presence of some species of fungi which are associated with the spoilage of *Solanum tuberosum* during storage. This includes *Fusarium spa, Aspergillus spa, Penicillium spa, Alternaria spa, Rhizopus spa and Mucor sp.* These organisms enhance storage losses influenced by factors such as temperature, humidity, respiration, water activity which accelerate the spread of the diseases, change the chemical composition and physical properties of the tubers. The results in this study corresponds with the findings of [27] in "mycological assessments of post-harvest rot of Irish potato from selected markets in Kaduna" where fungi such as Rhizopus *stolonifera, Fusariu exospore ,Aspergillus Niger, Aspergillus flavus, Penicillium spa* and *Mucor racemases* were isolated with their different frequencies. *Stolonifera* 6 (40.0%); F. *exospore* 4 (26.7%); Angier 2 (13.3%); *A. flavus* 1 (6.7%) *Penicillium species* 2 (13.3%) respectively.

Highest percentage frequency of occurrence of *Rhizopus stolonifera* against *Aspergillus flavus Aspergillus Niger, Penicillium species, Fusarium exospore, Mucor racemases, and Alternaria alternate* recorded by [30] in their study of "Identification of fungi associated with storage rots of Irish Potato (Solanum Tuberosum l.) tubers in Sokoto Metropolis", opposed the findings in this study were *Aspergillus spa* had the highest occurrence and frequency, this could be due to difference in location humidity and favorable growth condition.

Accordingly, two different species *Thiel avia Terri cola* and *Scapularies revivalist* were identified by [28] in the study of post-harvest survey and control of fungal rot pathogens in Irish potato (*Solanum tuberosum* l.) carried out in Biu local government area of Borno state. He recorded four fungal pathogens associated with the rot Irish potatoes (*Aspergillus flavus, Rhizopus stolonifera, Thiel avia Terri cola and Scapularies revivalist*), with *Rhizopus stolonifera* as the most frequent occurring while *Aspergillus flavus* had less frequency. *Thiel avia Terri cola* was found to be most pathogenic and had a rot lesion size of 14.11mm.

Conclusion

The phytochemical properties identified from the assessment of Irish potato (*Solanum tuberosum*) peels in this study were carbohydrate, flavonoid, Alkaloids, Saponin, phenolic compounds and protein which

were recorded to have medicinal value. Therefore, it can be suggested that these peels can be utilized in curing some ailments due to its potentials in therapeutics as proposed by traditional medicine practitioners. This potential was observed as an anti-inflammatory, anti-pyretic and analgesic activities and also fodder to animals for its protein content.

The fungal isolates associated with the spoilage of potato tubers (*Solanum tuberosum*) during storage identified in this study were *Fusarium spa, Aspergillus spa, Penicillium spa, Alternaria spa, Rhizopus spa and Mucor sp.* and each was found to be capable of independent spoilage of healthy tubers. Some fungi can produce mycotoxins which are hazardous to the health of consumers. There is need to improve on the storage condition, harvesting time, and prevent injury to tubers during harvest to minimize level of spoilage. Surface disinfection of the tubers is recommended after harvest and heat treatment during storage as consumption of fungi infected crops can be dangerous to health.

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