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Studies into the Efficacy of Neem Wood Ash in Controlling Storage Problems of Irish Potato *Solanum tuberosum l.*Tubers

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Abstract
The efficacy of neem wood ash in controlling three storage problems of Irish potato tubers namely: weight loss, sprouting and decay was tested in Kano (North – Western Nigeria) in different concentrations of 6.0g, 9.0g, 12.0g ash/per kg of Irish potato tubers. There were significant differences in these parameters throughout the period of storage but no significant difference (P=0.05) between the control in the different concentrations of neem wood ash as well as the interaction between weeks and concentrations of the ash for this period. The gross mean of weight loss, sprouted and decay tubers are 8.65%, 17.51%, and 7.0% respectively while the corresponding ranges are 4.17 – 19.25%, 5.12-35.53% and 1.35 – 18.44% respectively. However, no definite pattern in the mean weekly percentage weight loss, sprouted and decay tubers. This study shows that the botanical could control tuber decay (and to some extent weight loss) in stored irish potato tubers, but is however limiting in controlling storage problem of tuber sprouting. This on the other hand make the botanical suitable for storing seed IP for upward of 16 weeks.

INTRODUCTION

Irish potato, *Solanum tuberosum* L. is a common and very important staple crop in the world today (Rich, 1983). The crop which originated from South American around Andes Mountains was first cultivated by the Inca Indians around 200BC (Scott, 1976). Nevertheless, the introduction of this crop into Europe according to Hawkes (1967) was done in two stages namely; into Spain around 1570 and into England around 1590. The British Missionaries introduced the crop into India in the late 17th Century while the crop made its first appearance in Africa at about that time. Thus, within 400 years of its existence, Irish potato (IP) has become a household name in every continent of the world, and is the 4th in production after wheat, rice and maize. The crop thrives well under moist climatic condition, ligter soil with sufficient attitude (not less than 1,100m) to provide the required moderate temperature. This modified underground stem, vary in size, shape and colour according to cultivar. IP could be cooked/roasted either singly or with other food items like rice, yam, beans etc; spoilt or small tubers could also be made into starch, baking flour etc.

In Nigeria, IP is grown in commercial qualities in two states namely; Plateau State (Barkin-Ladi, Bokkos, Jos South, Mangu, Bassa and Panakshin Local Government Areas) and Taraba State (Sardauna L.G.A.). This is because of the high altitude and relatively low temperature of these areas. However, IP is being grown in “pocket” in Jigawa, Kaduna, Kano, Yobe, Gombe, Bauchi, Adamawa, Nassarawa and Zamfara States. The crop is grown all year round; during the dry season, it is grown under Fadama Irrigation Scheme. The dry season stock however has better storage value than the rainy season crop due to high moisture content of the later.

Post-harvest handling is however principal constraint to the production of the crop, especially in Nigeria. There are quite a number of storage problems of IP, but these could be summarized into three: Weight Loss, Sprouting and Decay – all of which lead to rapid deterioration of IP tubers under storage. In severe situations, a combination of these factors could lead to loss of farmer's / merchant's interest in potato business. These three problems are to some extent, interrelated. Weight loss is being caused by gradual or rapid evaporation of moisture from tubers, decaying, continuous growth of sprouts etc; controlling it and yet maintain fresh tubers in storage (without refrigeration) is often a precarious affairs in the tropics and subtropical region of the world. Sprouting of tubers (either seed or table size potato) is being caused by prolong and/or poor method of storage especially under higher temperature and moisture (Rich, 1983; and Burton *et. al,* 1992); the dormancy period of a particular variety also has a strong bearing on sprouting rates. When processed, sprouting tubers produce products that are bitter in taste and brownish in colour. The commonest way of dealing with the problem is the use of synthetic chemicals (sprout inhibitors suppressant) such as Maleic hydrazide (MH), trachlare nitrobenzene (TCNB), methylester of naphthalene-acetic acid (MENA), isopropyl N-(3-chloropheny) carbamate (CIPC), nenyl alcohol (Marth and Schulte, 1952; Smith 1977; Burton *et. al;*1992). Tuber decay/rot is being caused by bacteria such as *Fruinia sp, Xanthomenas solancearum* etc., some fungi e.g *Rhizoctonia, solani Fusarium sp. Atternaria solasni etc.* The spoilage activities of these micro-organisms is being aggravated by high temperature, deep pilling storage, water-logging of tubers before harvest, inadequate ventilation of the storehouse etc.

In addition to good storage practices, curtailing these storage problems requires the use of substances of which plant products (neem wood as in this case) might be a promising candidate.

Various products of neem tree (seed powder/oil, leave powder, extracts, bark, roots etc.) and their products have been variously used on different kinds of pests, acting variously as deterent, anti-ovipositional, anti-feedant, growth-disrupting and fecundity and fitness – reducing property. The plant has a long history (date back to the 1920s) of insecticidal activities and these has been well reviewed by Annon (1992). Neem products have also been proved to successfully control spoilage micro-organisms. Khan *et. al* (1974a) used neem oil cake/residue against the fungus *Rhizoctonia solani,* while Khan *et. al.* (1974b) successfully control*Fusarium sp.*with neem products; disease R. *Solani, Sclerotium rolfsii* and *sclerotinia Sclertiorium* on chickpeas and retard the development of *F oxysporum* though never kill it (Singh *et. al.* 1980). It is the goal of this research to investigate the efficacy of neem ash in the abatement of these micro-organisms that constitute the principal agents of spoilage in IP under storage.

MATERIALS AND METHOD

Freshly harvested round shape brown IP tubers were obtained from a farmer in Barkin-Ladi Local Government Area of Plateau State, Nigeria. This was carefully transported to NSPRI Station in Kano. Neem wood ash was obtained after burning the unwanted fell dried neem tree within the institute. The tubers were weighted out into 2.0kg each and treated with neem wood ash at the rate of 6.0g ash/kg IP tubers; 9.0g ash /kg; 15.0g ash /kg with 0.0g ash/kg as control. Each treatment was replicated three times and placed on ventilated yam shelf kept inside domestic/ventilated hut in the institute. Three parameters were determined on weekly basis; weight loss (%), sprouting (%) and decay (%), for 16 weeks – between 13^{th} October, 1999 – 2^{nd} February, 2000. The temperature inside the hut was also being noted. At the end of 16 weeks, the remaining tubers from each treatment were boiled separately and a panel of 15 individuals drawn from **NSPRI** staff and other members of the public were invited for palatability test for bitterness after storing with neem wood ash. This is because neem products have always been avoided due to their taste. Results obtained were statistically analysed and means separated using the Duncans Multiple Range Test **(DMRT)** on computer using System Analytical Statistics **(SAS).**

RESULTS

The analysis of variance **(ANOVA)** for the weekly percentage of

(i) Weight loss;
(ii) Sprouting;
(iii) Tuber decay are presented in Tables 1, 2 and 3 respectively.

From Table 1, there was significant loss in weight (weekly) throughout the sixteen weeks of storage irrespective of the concentration of the wood ash applied. Between the concentrations however, there was no significant weight loss recorded in the different treatments. Also, no significant loss were recorded in the interaction between the weeks and concentration of the wood ash. The mean percentage weight loss ranges from 4.17% (week 14) to 19.25% (week 7) with gross mean of 8.65%.

TABLE 1: Analysis of variance for percentage weight loss of ip after storage for sixteen weeks with different concentration of neem wood ash.

Source of Variation	Degree of Freedom	Anova sum of Square	Mean Square	F.Value	Pv>f
WEEK	15	3328.05	221.87	8.67	0.0001^{S}
CONCTRATION	4	220.12	55.02	2.15	0.077^{NS}
INTERACTION (WEEK X CONC)	60	1943.87	32.40	1.27	1.245^{NS}
ERROR	160	4093.85	25.59		
CORRECTED TOTAL	239	9585.88			

R-Square = 0.572929; C.V. = 58.50778; Root MSE = 5.0583
Mean = 8.6455; NS = Not Significant; S = Significant.

TABLE 2: Analysis of variance for weekly percentage sprouting of ip after storage for sixteen weeks with different concentrations of neem wood ash.

Source of Variation	Degree of Freedom	Anova sum of Square	Mean Square	F.Value	Pv>f
WEEK	15	27079.63	1805.31	21.12	0.0001[S]
CONCTRATION	4	704.61	176.15	2.06	0.0884[NS]
INTERACTION (WEEK X CONC)	60	5381.41	89.69	1.05	0.03986[NS]
ERROR	160	13677.84	85.47		
CORRECTED TOTAL	239	46843.56			

R-Square = 0.708010; C.V. = 52.80299; Root MSE = 9.2459
Mean = 17.510; NS = Not Significant; S = Significant.

TABLE 3: Analysis of variance for weekly percentage decay of ip stored for sixteen weeks with different concentrations of neem wood ash.

Source of Variation	Degree of Freedom	Anova sum of Square	Mean Square	F.Value	Pv>f
WEEK	15	5228.84	348.59	7.81	0.0001[S]
CONCTRATION	4	94.86	23.71	0.53	0.712g[NS]
INTERACTION (WEEK X CONC)	60	2644.91	44.08	0.99	0.5103[NS]
ERROR	160	7141.87	44.64		
CORRECTED TOTAL	239	15110.47			

R-Square = 0.527356; C.V. = 94.2389; Root MSE = 6.6811
Mean = 7.0895; NS = Not Significant; S = Significant.

TABLE 4: Mean of the weekly percentage weight loss of ip stored with five different concentrations (og, 6g, 9g, 12g, 15) of neem wood ash per kg of tubers for sixteen weeks.

WEEK	N	(%) MEAN WEIGHT LOSS
7	15	19.25 ± 10.61a
2	15	13.77 ± 5.12b
5	15	11.41 ± 2.76bc
3	15	9.82 ± 1.17cd
4	15	9.48 ± 0.83cd
9	15	9.37 ± 0.72cde
6	15	8.78 ± 0.13cdef
8	15	8.55 ± 0.10cdef
15	15	7.66 ± 0.99cdefg
1	15	7.56 ± 1.09cdefg
12	15	7.33 ± 1.32cdefg
16	15	6.99 ± 1.66defg
11	15	5.16 ± 3.49efg
10	15	4.78 ± 3.87fg
13	15	4.27 ± 4.38g
14	15	4.17 ± 4.48g

N.B: Mean with the same latter(s) and in the same column are not significantly different at (p>/0.05) level of significant.

TABLE 5: Mean of the weekly percentage sprouting of ip stored with different concentrations (og, 6g, 9g, 12g, 15) of neem wood ash per kg of tubers for sixteen weeks.

WEEK	N	(%) MEAN WEIGHT LOSS
16	15	35.53± 18.02a
15	15	33.29±15.78ab
13	15	29.64 ±12.13abc
14	15	29.46± 11.95abc
12	15	26.55±9.04bcd
11	15	22.91±5.40cde
10	15	20.58±3.07def
9	15	18.44± 0.93efg
8	15	15.22±2.29fg
7	15	11.96 ±5.55gh
6	15	6.97± 10.54h
4	15	6.54± 10.97h
2	15	6.37±11.14h
5	15	6.34±11.17h
1	15	5.24±12.27h
3	15	5.12±12.39h

N.B: Mean with the same latter(s) and in the same column are not significantly different at (p>/0.05) level of significant (DMRT).

The mean weekly percentage record of weight loss, sprouting and concentration of neem wood ash are fully presented on Tables 4, 5 & 6 respectively. In terms of IP tuber sprouting, there was significant difference (5%) in the weekly number of sprouting tubers throughout the sixteen weeks of IP storage. There was however no significant differences between the two factors – weeks and concentrations. Table 4 gives details of this.

The mean weekly percentage IP tuber spout ranges between 5.12% (Week 3) and 35.53% (Week 16) with a gross mean value of 17.5%. The high c.v. value of 52.80 is a prove of the reliability of the data. All theseare given in full on Table 5.

Similarly, tuber decay differs on weekly basis. But there were no significant differences in the concentration of the neem wood ash and the interactions of weeks and concentration. Mean

weekly percentage tuber decay ranges from 1.35% (week 13) to 18.44% (week 7). The pattern is however irregular, with a gross mean of 7.09 and a very high C. V. values of 94.24. These are shown on Table 6.
The temperature and relative humidity of the shed ranges between 20 – 28^{0}c and 55-65% respectively throughout the storage period.

TABLE 6: Mean of the Weekly Percentage Concentrations (Og, 6g, 9g, 12g, 15) of Neem Wood Ash Per Kg of Tubers for Sixteen Weeks.

WEEK	N	(%) MEAN WEIGHT LOSS
7	15	18.44± 11.35a
6	15	15.51±8.42a
5	15	10.39±3.30b
4	15	9.88±2.79dsc
3	15	9.56±2.47bc
8	15	8.51±2.42bcd
2	15	7.30± 0.21cde
9	15	6.39± 0.79bcdef
10	15	5.55±1.54bcdef
15	15	4.68±2.42cdef
12	15	4.46± 2.63cdef
16	15	3.73±3.36def
14	15	3.57± 3.52def
11	15	2.24±4.85def
1	15	1.97 ±5.12ef
13	15	1.35±5.74f

N.B: Mean with the same latter(s) and in the same column are not significantly different at (p>/0.05) level of significant.

DISCUSSION

The loss in weight recorded throughout the period of storage is common with roots and tuber crops stored in fresh form. This, according to Borton *et. al*. (1992), is traceable to evaporation of water from the tubers, respiration, physical properties of the tubers and extreme temperatures. Although good storage could abate such loss, but weight loss is inevitable since for the tubers to remain in good condition, exposure to fresh air is indispensable.

Moisture loss (to a bearable extent) is good for IP tubers under storage since this will reduce the activities of other spoilage agent such as decay, sprouting and other micro-organisms. That there was no significant difference (B=0.05) between the concentration of neem wood ash and weight loss shows the inability of this botanical to abate the problem in irrespective of how long for which it is stored under this condition, at least for upward of sixteen weeks. The above situations notwithstanding, the overall weight loss is still bearable (ranging between 4 and 19% with a mean of about 9%). This research shows that neem wood ash could be used to maintain up to 80% moisture content of IP tubers under this storage condition. Such level of moisture is no doubt, necessary for quick germination of roots and tubers crops. Percentage weight loss throughout the storage period is not in a steady patterm and this may be due to the weather condition of the period when the research was conducted.

As for weight loss, no significant difference in number of sprouted IP. According to Warr (1975), sprout is the "bud development on the seed tuber which had leaf initial present and at least partly open". The pattern of increase in number of sprouted tuber is such that there were fewer sprouted IP at the initial stage but this increases with age of the tuber. This is in agreement with the findings of Davidson (1958) that older seed had more sprouts. The increase in the number of sprouts is traceable to decreasing dominance of the apical growing region of the IP (Smith, 1977), Allen *et. al.* 1992). Sprout is removed on weekly basis throughout the sixteen weeks of storage. Thus, the above findings also agrees with Bates' (1935) that when the first sprout is remove from IP tubers, it give rise to the development of large number of sprouts. The lack of significant difference between concentration of neem wood ash and the interaction between weeks and concentration implies that the neem cannot serve as anti-sprout (sprout inhibitor) in IP.

Sprouting of IP tuber under storage decreases the size and quality (appeal) of IP and consequently large proportion of the tuber goes as trim waste. Such tubers are often not suitable for processing because they result in brownish and bitter product (Burton *et. al;* 1992). Sprouted seeds however produce larger yields than the unsprouted ones (Jarvis and Palmer 1973). Hence, for IP tuber under storage to sprout (recorded under this condition) could be taken as putting limits to the number of possible places of growth which may eventually grow (Allen *et. al.* 1992). The weekly sprouting of between 5 and 35% recorded under this investigation is recommendable and seed IP are suitably stored by this method to effect moderate sprouting required for effecting maximum growth and yield. Tuber decay results from high moisture content and low 0_2 supply. Apart from week one, the pattern of tuber decay shows a reversal trend compare to that of sprouting. Higher tuber decay are recorded in the sixteen weeks of storage. Tuber decay in IP is caused by bacteria. (e.g*Erwinia sp sp.).* Anon (1960). *Pseudomonas solanacsearum E. F.* Smith (Smith 1977) Corgnebacterium, sepedonicum (speieck and koth), *Fusarium caerulem* (Lib) sacc, (Blodegtt and Rich, 1950) and nematode such as *Ditylenchus destructor* (Thore, 1945) among others. Tuber decay ranges between 1.35 to 18.44% with a gross mean of 7.09. These figures are relatively low and bearable compared to situations where losses of over 80% has been recorded. Neem products have been reported for control of various micro-organisms (Khan *et. al.* 1974) a & Singh *et. al.* 1980). Thus, neem wood ash could be added to the list, especially in controlling tuber decay as regards micro-organisms attack.

CONCLUSION

On a general note, the botanical tested has proved effective to a reasonable extent, in controlling some storage problems of IP tubers especially tuber decay and weight loss, this could not have been possible without proper ventilation as provided for in the storage structure utilized for the research. Thus, a combination of neem wood ash applied on IP tubers kept in a ventilated place will significantly reduce losses of stored IP tubers.

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