Nigerian J. Anim. Sci. 2019, 21 (2): 214-222

Proximate composition, anti–nutritional factors and the effect of irish potato (*Solanum tuberosum l.*) peels on the performance and carcass characteristics of broiler chickens

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Target Audience: Farmers, Nutritionists and Researchers.

Abstract

The effect of replacing maize with lrish potato peel meal (IPPM) in the diets of broiler chickens was investigated, proximate analysis and anti–nutritional factor analysis were carried out. IPPM has a DM content of 90.03%, CP of 13.28, CF of 5.27, Oil of 0.32, Ash of 7.11, NFE of 74.02% and metabolisable energy of 3110.22 Kcal/kg. The content of anti–nutrients are phytate 1.84 mg/100g, tannins 3.96 mg/100g, oxalate 0.69 mg/100g, sapponin 1.60 mg/100g, trypsin inhibitors 2.40 mg/100g and cyanide 0.96 mg/100g. One hundred and eighty broilers of mixed sexes were randomly allotted to four dietary treatments of forty five (45) birds/treatment in a completely randomized design (CRD). Diet 1 was the control devoid of IPPM while diets 2, 3 and 4 contained IPPM at 5, 10 and 15% levels, respectively. Feed and water were provided ad–libitum throughout the study period that lasted 9 weeks. Routine management practices and vaccines were strictly adhered to. Data were collected on feed intake, weight gain and were used to calculate other growth parameters. At the end of the trial, two animals from each replicate were slaughtered, de-feathered, eviscerated and dissembled for carcass evaluation. There were significant ($p<0.05$) differences in weight gain, feed intake, feed cost/kg gain but mortality did not differ across treatments. Diets 2 and 3 compared favorably with the control. Results of carcass analysis showed significant ($p<0.05$) differences in dressing percentage and percentages of primal cuts such as drumstick, thigh, chest and back. Organs such as liver, lungs, heart, spleen, gizzard and kidneys also differ significantly ($p>0.05$) but intestines did not ($p>0.05$) differ across treatments. Results indicate that sun–dried IPPM can be included up to 15% level in broiler feed thus reducing the cost of production without adverse effect on the performance of the broilers.

Keywords: Broilers, Irish potato peels, Proximate, Anti-nutrient, Performance

Description of Problem

One great challenge facing Africa is the provision of sufficient food for its ever-increasing population. This is due to the rate of increase in human population, which is not matched with increase in food production. Nigeria is richly endowed with a variety of animal protein sources yet unable to provide this animal protein in sufficient quantity to meet the requirement of its citizenry. (12) recommended a minimum requirement of 54g of animal protein/person/day to be consistent with a balanced diet, sadly many Nigerians consume less than 10g/day. Low protein

consumption is a general problem in Nigeria and other developing countries (9). This is due to the shortage of animal products, which has led to the current high prices making them too expensive and unaffordable to an average Nigerian.

Increasing the animal protein intake at a reasonable cost to increase the diet quality of the populace has been part of the agricultural policy and the use of micro animals have been suggested (2). This requires directing efforts to the production of animals that are highly prolific with short generation intervals (5).

A major constraint to monogastric animal production is nutrition (6). Conventional feedstuffs such as maize, soyabeans, groundnut cake etc are expensive (12). There is a quest to look for alternative non-conventional feedstuffs that may be readily available and can replace conventional feedstuffs. Kitchen wastes such as plantain peels, yam peels, cassava peels and others have been explored for their feeding values in poultry nutrition (1;18;4). Potato peels is one major kitchen waste that is yet to be explored in animal nutrition.

Table 1: Composition of Broiler Starter Diets

	Composition			
	T1	T2	T3	T4
Ingredients				
Maize	53.50	48.50	43.50	38.50
SBM	38.00	38.00	38.00	38.00
Wheat-offal	5.00	5.00	5.00	5.00
IPPM	0.00	5.00	10.00	15.00
Bonemeal	2.50	2.50	2.50	2.50
Limestone	0.30	0.30	0.30	0.30
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Calc. analysis				
ME (Kcal/Kg)	2874.18	2855.12	2816.02	2785.35
CP (%)	23.00	23.00	23.00	23.00
CF (%)	4.33	2.68	4.09	4.36
Lipids (%)	2.99	3.74	3.91	4.41
Calcium	0.10	0.10	0.14	0.12
Available P	0.29	0.39	0.28	0.38
Lysine	0.10	1.24	1.31	1.22
Metionine	0.10	0.34	0.28	0.32
Cost/Kg (N)				

Vitamin-mineral premix provide per kg diet;Vit. A, 13340I.U; Vit D_3 2680I.U; Vit E, 10 I.U.; Vit K, 2.68mg; Calcium pentothenate, 10.68; Vit. B_{12} 0.022mg; folic acid, 0.668mg, choline chloride,400mg; Chlorotetracycline, 26.68mg; Manganese, 13mg; Iron,66.68mg; Zinc,53.34mg; Copper,3.2mg; Iodine, 1.86mg; Cobalt,0.268mg; Selenium, 0.108mg.

IPPM = Irish Potato Peel Meal
YPM = Yam Peel Meal
SBM = Soyabean Meal
ME = Metabolisable Energy
CP = Crude Protein
CF = Crude Fibre

Potato (S*olanum tuberosum L.*) is an important staple crop for human consumption. Potatoes are either eaten raw or processed into value–added products to meet the demand especially of fast foods and other convenience industries (Schieber *et al*, 2009). They are usually peeled during processing for domestic and industrial uses.

Potatoes are produced and consumed in large quantities in Nigeria. As a consequence of increased production, domestic consumption and processed potato products, considerable amounts of wastes are generated annually. The peels are the major portion of processing, produces waste that present a severe disposal problem to the home and potato industry, because the wet peels are prone to rapid microbial spoilage. They also contain an array of nutritionally and pharmacologically interesting components such as phenolic compounds, glycoalkaloids and cell wall polysaccharides which may be used as natural anti–oxidants, precursors of steroid hormones and dietary fibre (21).

Table 2: Composition of Broiler Finisher Diets

	Composition			
Ingredients	T1	T2	T3	T4
Maize	61.35	56.35	51.35	46.35
SBM	30.00	30.00	30.00	30.00
Wheat-offal	5.00	5.00	5.00	5.00
IPPM	0.00	5.00	10.00	15.00
Bonemeal	2.50	2.50	2.50	2.50
Limestone	0.30	0.30	0.30	0.30
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Calc. analysis				
ME (Kcal/Kg)	3008	2998	2969	2929
CP (%)	20.00	20.00	20.00	20.00
CF (%)	4.03	4.16	4.42	4.71
Lipids (%)	3.68	3.77	3.86	3.95
Calcium	0.08	0.07	0.08	0.10
Available P	0.37	0.36	0.36	0.38
Lysine	1.44	1.03	1.02	1.01
Metionine	0.32	0.29	0.30	0.28
Cost/Kg (N)				

Vitamin-mineral premix provide per kg diet;Vit. A, 13340I.U; Vit D_3, 2680I.U; Vit E, 10 I.U.; Vit K, 2.68mg; Calcium pentothenate, 10.68; Vit. B_{12} 0.022mg; folic acid, 0.668mg, choline chloride,400mg; Chlorotetracycline, 26.68mg; Manganese, 13mg; Iron,66.68mg; Zinc,53.34mg; Copper,3.2mg; Iodine, 1.86mg; Cobalt,0.268mg; Selenium, 0.108mg.

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However, very little or no work has been done on the inclusion of Irish potato peel meal in poultry diets. This study is therefore designed to evaluate the nutritive value of irish potato peel meal based diet on the growth performance of broiler chickens. The objective of the study is to determine the proximate composition and anti-nutritional factors in sun–dried lrish potato peels, its effects on the performance and carcass characteristics of broiler chickens and the economic implication of using Irish potato peel meal based diets in broiler nutrition.

Materials and Methods

The study was carried out at the Teaching and Research farm of the dept. of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. Zaria is located within the Northern Guinea Savanna Zone on latitude $11^0$9' 06" N and longitude $7^0$38'55' E, at an altitude of 706m above sea level. The maximum temperature varies from 26-32^{0}C depending on the season while the mean relative humidity during the dry and wet season are 21 and 72%, respectively. (Meteorological unit, Institute of Agricultural Research, Ahmadu Bello University Zaria, 2009).

Table 3: Proximate Composition of Sun-dried Irish Potato Peels

Feed Ingredient	% Composition
Dry matter (%)	90.03
Crude protein(%)	13.28
Crude fibre (%)	5.27
Ash(%)	7.11
Ether Extract (%)	0.32
Metabolisable Energy (Kcal/Kg)	3110.22
Nitrogen Free Extract (%)	74.02

Bio-chemical Laboratory, Dept. of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria.

Table 4: Anti-nutritional Factors in Irish Potato Peels

Parameters	**Composition (mg/100g)**
Oxalate	0.48
Phytate	1.43
Sapponnin	1.10
Tannin	2.13
Trypsin inhibitors	1.39
Cyanide	0.84

Bio-chemical Laboratory, Dept. of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria.

Table 5: Performance of broiler starter fed varying levels of IPPM replacing maize

Parametres	T1	T2	T3	T4	SEM
Initial weigt(g)	63.33	63.33	63.33	63.33	NS
Final weight (g)	642.22[a]	631.11[a]	596.67[b]	491.11[c]	16.23
ADWG (g)	20.67[a]	20.29[a]	19.05[b]	15.28[c]	0.58
ADFI (g)	19.28[b]	19.36[b]	19.76[a]	19.36[b]	0.20
Feed:Gain	0.93	0.95	1.04	1.26	NS
FC/Kg gain (N)	95.24[a]	95.37[a]	101.63[a]	115.97[b]	6.72
Mortality	0.00	0.00	0.00	0.00	NS

abc= means on the same row with different superscript differ significantly among treatments ADWG=average daily weight gain, ADFI=average daily feed intake, FC=feed cost

One hundred and eighty (180) day-old broilers of mixed sexes with an average initial weight of 63.33g were used for the experiment, they were housed in a deep litter house. They birds were allocated into four dietary treatments in a complete randomized design. Each treatment had three replicates with forty five animals per treatment. Feed and water were provided *ad-libitum* throughout the 9 weeks experimental period.

Irish potato peels were gathered from some households, restaurants and commercial fryers in Jos and Bukuru metropolis. The peels were sun-dried, and milled before being subjected to proximate and anti-nutritional factor analyses and then incorporated into the diets. Four diets were formulated as shown on table 1: T1 is devoid of the Irish potato peels and serve as control while T_2, T_3 and T_4 had Irish potato peels replacing maize at 5, 10 and 15%, respectively.

Samples of the sun-dried lrish potato peels were taken to the laboratory for proximate analysis and that of anti-nutritional factors at the bio-chemical laboratory of the Dept. of Animal Science and Food Research Programme laboratory of Institute for Agriculture Research, (IAR), Ahmadu Bello University Zaria.

Initial weights of the birds were taken on the 1st day of the experiment, they were weighed weekly thereafter to know the weight gain which was used to calculate average daily weight gain. At the end of the fourth week (Starter phase), the birds from the same treatments were pooled together and fed for a week before they were again randomized for the finisher phase of the experiment. Feed consumption was also measured weekly as well as water consumption. At the end of the feeding trial, six birds were randomly selected from each treatment and used for carcass analysis. The birds were fasted overnight and weighed before being slaughtered, dissected, eviscerated and dissembled into whole cut and each primal part as well as organs were weighed. The data collected was subjected to analysis of variance, significant differences among treatment means were separated using the Duncan multiple range test in the SAS package.

Results and Discussion

The proximate and anti-nutritional compositions of sun-dried Irish potato peels showed a dry matter content of 90.03%, which is similar (P>0.05) to the 93.02% reported for yam peels by (15) and 88.80% reported for yam peels by (14). The proximate composition of Irish potato peels is presented in Table 2. Irish potato has a crude protein of 13.28 % which is higher than 11.06% and 11.33%

reported for yam peels by (15) and (4), respectively. It has a crude fibre content of 5.26%, which is lower than 6.04% and 6.3% reported by (15) and (6) for yam peels. It has ether extract of 0.32%, which is lower than 1.69% reported by (15), and ash content of 7.11%, which is higher than 5.93% reported by (15) but within the same range of 6.80% reported by (6). IPPM has nitrogen free extract of 74.02% that is close to the range of 75.28% reported by (15). It has a metabolisable energy value of 3110.22kcal/kg, which is also close to 3164 kcal/kg of (15). It is also within the range of 2988kcal/kg and 3404kcal/kg reported by (4) and (14) for Yam peels. The proximate composition shows that Irish potato peels could be a good energy source in livestock diets and result of anti-nutritional factors indicates they are within tolerable limits hence will not have any negative effects if included in livestock diets. It is presented in Table 4.

Table 6: Performance of broiler finisher fed varying levels of IPPM replacing maize

	Treatments				
Parametres	**T1**	**T2**	**T3**	**T4**	**SEM**
Initial weight	578.30	580.95	580.10	576.79	NS
Final weight	2195.43^{a}	1971.83^{b}	1837.87^{bc}	1717.87^{c}	111.89
ADWG	57.75^{a}	49.67^{b}	44.69^{bc}	40.86^{c}	3.98
ADFI	97.02	88.56	89.18	87.58	NS
Feed:Gain	1.68^{a}	1.78^{a}	1.95^{a}	2.01^{b}	0.28
FC/Kg gain	158.58^{a}	164.35^{ab}	176.24^{ab}	205.96^{ab}	51.0
Mortality	0.00	0.67	0.33	0.67	NS

abc= means on the same row with different superscript differ significantly among treatments ADWG=average daily weight gain, ADFI=average daily feed intake, FC=feed cost

Performance of broiler starter chickens fed varying levels of dried Irish potato peel meal based diet is presented in Table 5. There were significant differences (P<0.05) on weight gain, feed intake, feed cost/kg gain but there was no mortality across treatments in the starter phase. Those fed 5% had higher weight gain, feed to gain ratio and feed cost/kg gain. Feed intake is higher in T_1 and differs significantly (P<0.05) from T_3 and T_4 that are significantly similar and they also differ from T_2. On feed to gain ratio, they are similar across treatments, for feed cost per kg gain, T_4 has the highest and also differs significantly from T_2 and T_3 that are similar and there was no mortality at the starter phase.

The significant increase in feed intake with increasing levels of Irish potato meal in the diets may be attributed to lower metabolisable energy of Irish potato peel meal. This observation agrees with that of (15);(7) for birds fed yam peel meal. It also agrees with the report of (7) who reported same as (15). These authors reported that birds on yam peel meal consume higher in order to meet their energy requirement. The result followed the same pattern as the final weight of broiler chicks obtained in the study.

Performance of broiler finisher chickens fed varying levels of dried Irish potato peel meal based diet is presented in Table 6. There were significant differences (P<0.05) in weight gain, feed to gain ratio and feed cost/kg gain. Mortality and feed to gain ratio did not differ across treatments. The birds on 5% inclusion compares favourably with the Control, all the birds perform well in all the other treatments though slightly lower than the control.

Table 7: Carcass characteristics of broilers fed varying levels of IPPM as a replacement for maize

Parametres	T1	T2	T3	T4	SEM
Live-weight (g)	1825.00[a]	1700.00[c]	1775.00[b]	1650.00[d]	42.08
Slaughter Wt(g)	1700.00[a]	1600.00[b]	1700.00[a]	1474.00[c]	31.73
Dressed wt(g)	1650.00[a]	1550.00[b]	1650.00[a]	1400.00[c]	38.18
Carcass wt (g)	1400.00[a]	1175.00[b]	1200.00[b]	1183.33[b]	52.56
Gizzard full (g)	64.00[c]	80.67[a]	80.67[a]	72.67[b]	3.36
Gizzard empty(g)	45.33[c]	50.67[a]	53.67[a]	44.00[c]	6.27
Liver (g)	33.00	33.33	34.67	35.00	NS
Lungs (g)	11.00[b]	13.67[a]	10.33[c]	11.33[b]	2.02
Kidney (g)	6.00[c]	10.00[a]	7.00[b]	4.67[d]	1.30
Heart (g)	5.67[c]	12.00[a]	8.00[b]	7.00[b]	2.41
Spleen (g)	1.67[c]	2.67[b]	5.67[a]	2.00[c]	0.91
Intestine full(g)	111.33	129.00	112.00	119.00	NS
Intestine empty(g)	83.67	84.00	79.00	79.67	NS
Intestinal length (cm)	101.00	104.33	101.33	97.00	NS
Legs (g)	78.33[b]	73.33[b]	90.67[a]	67.67[c]	5.76
Head (g)	48.33[a]	44.00[b]	48.00[a]	44.33[b]	2.78
Abdominal Fat(g)	19.00[a]	18.67[a]	9.67[b]	22.33[a]	6.23
Neck (g)	91.33[a]	77.33[b]	90.00[a]	71.33[c]	4.32
Breast (g)	306.67[a]	297.00[a]	310.00[a]	278.33[b]	30.28
Back (g)	233.67[a]	201.67[c]	213.00[b]	194.67[c]	11.01
Thigh (g)	206.33[a]	185.00[b]	214.00[a]	202.00[a]	14.62
Wings (g)	143.33[a]	129.33[b]	148.67[a]	132.00[b]	10.02
Drumstick (g)	186.67[a]	165.33[b]	186.67[a]	150.33[c]	6.02

abc= means on the same row with different superscript differ significantly among treatments

There was cost saving with the use of Irish potato peel meal at all levels in the diet of the birds. This result in a considerable reduction in the cost of poultry production, and by extension the product was more affordable to consumers. This agrees with the reports of (6);(15) that reported lower feed cost/kg gain with increasing levels of yam peel meal in poultry diet. Results from this study indicates that Irish potato peel meal could serve as replacement for the more expensive maize, which is a conventional energy source in livestock feed formulation.

Effect of feeding varying levels of Irish potato peel meal on carcass characteristics is presented on Table 7. There were significant differences in dressing percentage and carcass weight and that of primal parts like breast, back, thigh, drumstick and wings. Internal organs such as lungs, heart, spleen, kidney and gizzard also differ significantly but without any trend. There were also significant differences on head and legs. But the intestine did not differ significantly across treatments. This may be due to numerically higher live weight of the birds in the various treatment groups.

Liver was not significantly affected by Irish potato peel meal In diet and the control. This could be due to the sun drying that may have reduce the anti-nutritional factors such as glycoalkaloids and other phenolic compounds that are toxic in irish potato peels to levels that were no longer toxic. Liver plays a major role in detoxification of anti-nutritional factors. Based on the result on growth performance, birds on T_2 and T_3 compared favourably with T_1 (control) with respect to weight gain, feed intake, feed to gain ratio and feed cost/kg gain. However, in all the treatments, there was no mortality at the starter phase and even at the finisher phase, there was no significant differences ($P<0.05$) in mortality during the trial. This may be attributed to good management practices and adherence to routine vaccination schedules adopted and probably the breeds were hardy (15) also reported significant differences in primal parts. However, this work did not agree with her as she reported significant differences in liver but this work did not observe that.

Conclusion and Applications

From the trial and based on growth and carcass quality, it was concluded that:

1. 5 and 10% inclusion levels of Irish potato meal compared favourably with the control in weight gain, feed conversion ratio and feed cost/kg gain.
2. 15% level compares favourably with control in carcass quality
3. Sun-dried Irish potato meal can replace maize up to 15% level in broiler chickens nutrition without compromising productivity
4. Detailed mineral and vitamin analysis of the peels should be carried out to know its suitability for other uses in human and livestock nutrition.
5. Other processing methods like heating or cooking at high temperatures (over 170^0 C or 340^0F) as well as the use of enzyme may be tried to see if it will give better results than the one obtained in this study.

References

1. Aduku, A. O. (1992). Practical Animal Feed Production in the Tropics. S. Asekome and Co.Publishers, Samaru, Zaria.
2. Aduku, A.O., and Olukosi, J.O., (1990). Rabbit Management in the Tropics. Living Book Series, GU Publications, P.O. box 2280, Abuja, Nigeria.
3. Aduku, A.O., Dim, N.J., and Ogundipe, S.O. (1991). Evaluation of Sun-dried Cassava Peels as Energy Source in Broiler Diets. A paper presented at the 6th annual conference of Nigerian Society of Animal Production held at Usman Danfodio University, Sokoto, Nigeria March, 1991. Pp1-14.
4. Akinmutimi, A.H., Obasienkong, S.F., and Odoemelam, V.U. (2006). Effect of Replacing Maize with Ripe Plantain and Yam Peels in the Diet of Weaner Rabbits. Journal of Animal Science and Veterinary Advances 5 (9): 73-740.
5. Akinmutimi, A.H., and Anakebe, O.C. **(**2008). Performance of Weaner Rabbits Fed Graded Levels of Yam and Sweet Potato Peel Meal in Place of Maize-Based Diet. Pakistan. Journal of Nutrition 7: (5): 700-704.
6. Akinmutimi, A.H., and Onen, G.E. (2008)**.** The Response of Broiler Finisher Birds Fed Graded Levels of Yam Peel Meal in Place of Maize-based Diets. International Journal of Poultry Science 7 (5): 474-479.
7. Alozie, S.O. Agbakoba, A.M., Lgbokwe M.C., Enead, L.S., and Azubuike, G.O., (1987). Technical Annual Paper. National Root Crops Research Institute, Umudike, Nigeria. Pp 34-39.

8. AOAC (1990). Association of Official Analytical Chemists Method of Analysis (15th edition). Published by the Association of official and Analytical chemists, Washington D.C.
9. Ayorinde, I.A., and Aromolaran, A.B., (1998). Economics of rabbits Production in Abeokuta South L.G.A of Ogun State, Nigeria Nigerian Journal of Animal Production, 25: 100-105.
10. Camire, M.E., and Flint, S.I., (1991). Thermal processing effects on dietary Fiber composition andhydration capacity in corn meal, oat meal, and potato peels. Cereal Chemistry. 68: 645-647.
11. Cheeke, P.R., Grobner, M.A., and Patton, N.M., (1986). Fibre Digestion and Utilization in Rabbits. Journal of Applied Rabbit Research 7 (1): 31-37
12. Food and Agricultural Organization (FAO, 1993). Food and Agriculture Organization production year book. Rome
13. Friedman, M. (2006). Potato glycoalkaloids and metabolites: roles in the plant and in the diet. Journal of Agricultural and Food Chemistry. 54: 8655 – 8681.
14. Igwebuike, J.U., Mohammed, G., Asheikh, L.G., Ugosi, C.O., and Mohammed, B., (2009). Effect of partial replacement of maize with yam peel meal on the growth and economic performance of broiler chickens. Proceedings of the 14th annual conference of the Nigerian Society for Animal Production (NSAP), LAUTECH Ogbomosho, Oyo state, Nigeria. 14 – 17th September, 2009.
15. Inaku, E.N., (2011). Nutritive Value of Sun–Dried Yam Peel Meal in Broiler Diets. M Sc. Thesis submitted to the Department of Animal Science, Ahmadu Bello Unversity, Zaria, Kaduna State.
16. Mahmood, A.U., Greenman, J., and scraggy, A.H., (1998). Orange and potato peels extracts: analysis and use as bacillus substrates for the production of extracellular enzymes in continuous culture. Enzyme and microbial technology. 22: 130-137.
17. Marfo, H.D., and Oke, O.L., (1998). Changes in phytate content of some tubers during cooking and fermentation. Critical review on food science and nutrition. 12:371 – 405.
18. Nworgu, F.C., and Ogbosuka, G.E., (2003). Ripe plantain (Musa paradica) peels meal as an alternative energy source for weaned rabbits, Nigerian Soc. Anim. Prod. Proce, pp:348.
19. Obigbesan, G.O., (1976). Report on potato production in Nigeria. International potato course: production, storage, and seed technology report of participants. International Agricultural Center, Wageningen, the Netherlands.
20. Raddy, T.S., (1987). Use of nonconventional feed item in poultry rations, their effects on growth and egg production. Poultry adviser. 20 (1): 33-36.
21. Schieber, A., Marleny, D., and Aranda, S., (2009). Potato peels: a source of nutritionally and pharmacologically interesting compounds – a review. Global science books. 23 – 29