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Dietary effects of substituting maize for yellow cocoyam (*Xanthosoma sagittifolium*) as energy source for weaner pigs

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ABSTRACT: Due to consistent increases in the prices of conventional feeds, researchers have started looking for alternative sources of feeds. The research was conducted to investigate the dietary effect of substituting maize for cocoyam (*Xanthosoma sagittifolium*) as energy source for weaner pigs. The experiment was conducted at the Swine Unit of the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State, Nigeria. The cocoyam was collected and processed by sun-drying to form a cocoyam corn meal (CCM). A total of 16 weaner pigs of large white breeds were used for the study. The pigs were divided into 4 groups based on average initial body weights (20-25 kg) and each group of weaner pigs were respectively allotted to each of the four treatment diets using a Completely Randomized Design (CRD). Each treatment group contained two replicates of four pigs, two males and two females). These pigs were fed twice daily and water supplied *ad-libitium*. Four diets were formulated to contain 0, 20, 40 and 60% of CCM. Data were collected on growth performance and blood profile. Result revealed that there was significant ($p<0.05$) differences in all the growth performance parameters measured. No significant differences ($p>0.05$) were observed on all blood profile parameters measured except the albumin and creatinine. The albumin and creatinine values ranged from 2.63-3.52 g/dl and 0.90-1.50 mg/dl respectively. It was concluded that weaner pigs fed 20% CCM based diet has significant effect on the growth performance of pigs. This implies that CCM at 20% showed more effect on the growth performance of pigs compared to other levels of diet. It was therefore recommended that cocoyam corn meal should be encouraged in the feeding of pigs to reduce over dependence of maize feeds by our farmers which has led to the high cost of raising monogastric specifically pigs thereby discouraging farmers from investing in the swine business.

Keywords: Maize, Cocoyam, growth performance, weaner pigs.

INTRODUCTION

Consistent increase in the cost of conventional swine feedstuffs in Nigeria has led to the search and utilization of alternative feed sources for swine (Obidinma, 2009; Esiegwu and Okonkwo, 2018). Besides, depending on maize alone as the sole source of dietary energy may be devastating to swine production, because of the frequent drought and locust attacks affecting some maize producing areas. Inadequate production of maize which is the major conventional energy feed source to meet the energy requirements for man, livestock and raw material for industries (Anyaehie, 2017), created the need to look for cheaper, readily available and alternative sources of energy feedstuff for pigs such as yellow cocoyam corm known as "*ede uhie*" in Igbo, *kokoibile* in Yoruba and

Gwamba in Hausa (Ndimantang *et al.,* 2006).

Cocoyam products are recognized as cheaper carbohydrate sources than grains or other tuber crops. Thus, tannia cocoyam (*Xanthosoma sagittifolium*) is a non-conventional feedstuff that provides readily available energy with easily digestible carbohydrates. *Xanthosoma sagittifolium* is readily found in all hot and humid areas of the world and is cultivated extensively throughout West Africa (Onwusu-Darker *et al.*, 2014 as cited in Okonkwo, 2020). It was suggested that tannia cocoyam are now more important than taro cocoyam (*Colocasia esculenta*) being more popular (FAO, 2000), due to the superiority of their corms and cormels in terms of energy, proteins and mineral elements (Matikiti *et al*., 2017).

Cocoyam is a collective name for species of *Colocasia* and *Xanthosoma* genera from a family of *Aracea* (Opara, 2003; Rao *et al.,* 2010). Cocoyam is a herbaceous annual and perennial crop with underground roots known as corms which contain a high amount of starch (Rao *et al.,* 2010). *Xanthosoma sagittifolium* is very nutritious and highly productive and yet its corms and cormels are being underutilized as energy feed resources (Onu and Madubuike, 2006; Owusu-Darko *et al.,* 2014; Eyasu *et al.,* 2019). The cocoyam corm can be processed into fufu and the cormels can also be used in soup thickening or serve as portage with vegetables in Igbo land (Onu and Madubuike*,* 2017). It is also a source of dietary energy, proteins, vitamins and as well high in potassium, zinc and nicotic acid (Aboubakar *et al.,* 2008).

Cocoyam corms contain anti-nutritional factors such as tannins, hydrocyanid, oxalates, antitrypsin inhibitor (Okereke, 2012; Hang and Binh, 2013). The anti-nutritional factors in the cocoyam corms could be removed through drying, fermentation, cooking and toasting to make the product safe for human and livestock consumption (Ndimantang *et al.,* 2006; Eyasu *et al.,* 2019). Ndimantang *et al.* (2006), Aboubakar *et al.* (2008), Akinmutimi *et al.* 2006) and Subhash *et al.* (2012) observed that *Xanthosoma sagittifolium* corn meal proved to serve as good food for both man and livestock with its appreciable nutritional profile and higher productivity. Ndimantang *et al.* (2006) went further to say that cocoyam corn flour *(Xanthosoma sagittifolium)* contains about 132 calories in a cup of dried and ground corms of 135 g, 0.347 mg copper, 0.32 mg of vitamin B6, 31.9 gm of carbohydrates, 8.07 mg of potassium, 1.32 mg of iron, 1.131 mg of vitamin B1, 0.257 mg of manganese and 9.74% protein. Owusu – Darko *et al.* (2014), evaluated the potentials of cocoyam corms and cormels and expressed dismay for an underutilization and under exploitation of this arable crop by consumers. However, Iwuoha and Kalu (1995), Noonan (1999), Dosumu *et al.* (2012) and Zhu (2016) reported some anti-nutritional factors in cocoyam corms and cormels especially calcium oxalate and physico-chemical properties which can hinder their utilization as food if not well processed. In other to proffer solutions to these problems posed by these anti-nutritional factors of cocoyam corms and cormels, Sefa-Dedeh *et al.* (2004) observed that calcium oxalate, tannin, hydrocyanid etc could be removed through good processing methods such as drying, soaking or cooking and could make the corn meal safe for consumption and for other industrial uses. Matikiti *et al*. (2017) observed that the proximate nutritional composition of cocoyam were in the range of 65-78% moisture, 2-5% ash, 0.2-1.10% fat, 2.5-5% fibre, 14-23% carbohydrates, 390-460 mg/100g potassium, 24-43 mg/100g calcium, 79-91 kcal/cal energy, 4.8% protein and 79-110mg/100g magnesium.

Thus, the study was targeted to investigate the dietary effects of substituting maize for yellow cocoyam (*Xanthosoma sagittifolium*) as energy source on weaner pigs.

MATERIALS AND METHODS

Location of study

The experiment was carried out at the Swine unit of the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State, Nigeria. It is located in the coastal southern part of the country, lying between latitudes 4°32^{1}N and 5°33^{1}N, and longitudes 7°25^{1}E and 8°25^{1}E. The state is located in the south-South geographical zone, and is bordered on the east by Cross River State and Rivers State, on the west by Abia State, and on the south by Atlantic Ocean and the south-most tip of Cross Rivers State.

Collection and preparation of test ingredients

The cocoyams used for the experiment were gotten from the research farm of the University of Uyo, Uyo, Akwa Ibom State. The corms were peeled, washed, cut into pieces and sundried for 15 days so that it could be crispy while milling using a hammer mill. The dried cocoyam corn meal (DCCM) was taken to the laboratory for proximate analysis according to AOAC (2010). Four weaner diets; T1 (control), T2, T3 and T4 were formulated in which dried cocoyam corn meal was added to partially replace maize at 0, 20, 40 and 60% respectively.

Experimental animals

A total of 16 weaner pigs of large white were used for the study. The pigs were divided into 4 groups based on average initial weights (20-25 kg) and each group of grower pigs were respectively allotted to each of the four treatment diets in a completely randomized design (CRD). Each treatment group contained 2 replicates of 4 pigs (2

Table1. Composition of experimental diet for weaner pig.

Ingredients	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)
Maize	60.00	40.00	20.00	0.00
Cocoyam corm meal	0.00	20.00	40.00	60.00
Soya bean meal	15.00	15.00	15.00	15.00
Fish meal	4.00	4.00	4.00	4.00
Blood meal	1.00	1.00	1.00	1.00
Wheat Offal	24.10	24.72	24.51	24.25
Palm kernel cake	10.30	10.30	10.30	10.30
Bone Meal	1.50	1.50	1.50	1.50
Limestone	2.00	2.00	2.00	2.00
Weaner Premix*	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35
L- Lysine	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Dry matter	92.00	89.23	88.83	87.28
Crude protein (%)	19.00	21.00	23.00	25.00
Ether extract	7.48	5.19	4.58	2.60
ME(Keal/Kg)	2978	2957	2935	2913
Fibre (%)	5.35	6.99	8.63	10.26
Ash (%)	5.94	9.11	12.34	15.57
Phosphorus (%)	36.23	40.23	42.48	44.25
Lysine (%)	0.21	0.43	4.06	6.32
Calcium (%)	46.01	34.23	25.28	33.23
Cellulose	34.00	23.98	13.32	22.99
Methionine (%)	6.32	8.86	6.99	13.34

boars and 2 sows). The experimental animals were dewormed for two weeks before the test was administered. The animals were fed twice daily and water supplied *ad-libitium*.

Data collection

Feed intake and live weight gain**:** At the beginning of the experiment, the pigs were weighed on a daily basis prior to feeding in the morning and evening. The initial live weight was subtracted from the final live weight to determine the weight gained by the animals. Feeds offered and remnants were weighed daily to determine the feed intake of the animals. Both values were used to determine feed conversion ratio (FCR).

Statistical analysis

Data were subjected to analysis of variance using the procedure outlined by SAS (2002) and significantly different means were compared using the multiple range test by Duncan (1955).

RESULTS AND DISCUSSION

Table 2 shows the proximate analysis of dried cocoyam corm meal *(Xanthosoma sagittifolium)* used for this study. The crude fibre, crude protein, ash, ether extract moisture, dry matter, nitrogen free extract and metabolizable energy are: 5.60%, 8.10%, 3.89%, 5.00%, 79.00%, 80.10%, 47.87% and 2421.98 Kcal/kgDM respectively. These values were in line with the values obtained by Okonkwo (2020).

The result of the performance of pigs fed dried cocoyam corn meal is shown in Table 3. Feed intake increased as the levels of dried cocoyam corn meal increased in the diets though there were no significant ($p>0.05$) difference among the treatment groups, T4 had the highest ($p<0.05$) feed intake among other groups while T1 had the least ($p<0.05$). The results of feed intake obtained in this study are in agreement with observations of Esonu (2002a and 2000b) and Ndimantang *et al.* (2006) who reported that cocoyam corm meals were very rich in nutrients and very palatable and therefore increases their acceptability in swine diets. On body weight gain, pigs placed on diets 2 (T2) had significance ($p<0.05$) least weight gain among the

Table 2. Proximate composition of cocoyam corn meal.

Ingredients	Composition
Crude fibre (%)	5.60
Crude protein (%)	8.10
Ash (%)	3.89
Ether extract (%)	5.00
Moisture	79.00
Dry Matter	80.10
Nitrogen Free Extract	47.87
ME (Kcal/kg)	2421.98Kcal/kgDM

Metabolizable = (37 × %CP) + (81.8 × %FAT) + (35.5 × %NFE) (Pauzenga, 1985) ME metabolizable.

Table 3. Growth Performance characteristics of pigs fed experimental diet.

Parameters	Levels of inclusion (%)				SEM (±)
	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)	
Ave. initial weight(kg)	9.05	8.98	9.00	9.01	
Ave. final weight(kg)	28.84^{b}	30.67^{a}	25.00^{c}	38.50^{d}	0.46
Ave. total weight gain(kg)	12.52^{b}	23.79^{a}	16.00^{d}	30.50^{cd}	0.44
Ave. daily weight gain(kg)	2.07^{b}	2.40^{a}	2.06^{c}	1.78^{cd}	0.64
Feed intake(kg)	35.00	35.00	35.00	35.00	0.01
Feed conversion ratio	2.31^{c}	2.16^{d}	2.69^{b}	2.80^{b}	0.68
Protein efficiency ratio	2.18^{b}	2.52^{a}	1.95^{c}	1.88^{cd}	0.08
Mortality (%)	-	-	-	-	-

^{a,b,c,d,e} means along the same row with different superscripts are significantly ($p< 0.05$) different from each at her, Ave: Average, SEM: Standard error of mean.

treatment groups, T1 and T3 groups were the same ($p>0.05$) while T4 had the highest ($p<0.05$) weight gain among other groups. This obviously implies that cocoyam corn meal (*Xanthosoma sagittifolium)* improved adequate weight gains that are required for maximum meat production. This is in agreement with Okonkwo (2020) who stated that growth require synthesis of new body tissues and the raw materials for growth have to be provided through feed and feedstuffs that are adequate for it. In weaner pigs that are reared for other purposes, production however is influenced by growth which has to be attained to a particular point (1.5 to 2 kg). More so, higher feed intake of T4 pigs did not match the meat production value recorded in this study. This experiment showed that 20% inclusion of cocoyam corn meal supported meat production, body weight and feed efficiency more than 20% inclusion (T4). On feed conversion efficiency, T4 had the highest ($p<0.05$) (2.80) among other groups followed by T3 (2.69) and then T1 (2.31) and T2 (2.16) which had the lowest ($p<0.05$), though there were no significant ($p>0.05$) difference among the treatment groups on feed conversion ratio. This is in line with Iheukwumere *et al.* (2008) and Esonu (2000b) who stated that weaners pig diets should be adequate with regard to essential nutrients to improve feed efficiency and feed utilization. Also, Effiong *et al.* (2015) and Singh *et al.* (2013) reported positive influence on pig day production, body weight and feed efficiency on pigs fed adequate diets in terms of quality and quantity. It is important to state here that as at the time this experiment was carried out, very little information was available on the inclusion of yellow cocoyam corn meal (*Xanthosoma sagittifolium)* as feed ingredient in weaner pig diets.

The results of haematological analysis of weaner pigs fed dried cocoyam corn meal are shown in Table 4. Haematological parameters such as haemoglobin, packed cell volume, red blood cell volume tend to decrease as the levels of cocoyam corn meal increased in the diets but did not follow a definite order. More so, all the values obtained were within the normal range for pigs which were in line with Merck Veterinary Manual (2016). The mean cell haemoglobin concentration increased ($p<0.05$) for pigs fed high inclusion levels of cocoyam corn meal in their diets. T2 had the highest ($p<0.05$) cell haemoglobin concentration (31.02 pg) followed by T4 (29.55 pg) which differed significantly ($p<0.05$) from T1 (29.03 pg). The

Table 4. Haematological indices of parameter of weaner pigs fed with cocoyam corm meal (CCM) based diet.

Parameters	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)	SEM
HB(g/dl)	11.97	11.77	11.68	11.73	0.88
PVC (%)	33.08	31.63	31.88	31.88	2.66
RBC(x106/UL)	2.56	2.59	2.69	2.53	0.27
MCV (fl)	131.98^{a}	125.18^{b}	126.85^{ab}	126.85^{ab}	5.23
MCH (pg)	38.88^{a}	38.88^{b}	37.53^{b}	37.53^{b}	1.19
MCHC (%)	29.03^{b}	31.02^{a}	29.33^{b}	29.55^{ab}	1.38
PLT (x103/UL)	22.67^{a}	20.83^{a}	18.33^{a}	20.50^{a}	1.37
WBC (x103/UL)	83.78^{a}	73.13^{ab}	82.00^{ab}	75.33^{b}	6.15
LYM (%)	77.67^{c}	83.83^{abc}	81.00^{bc}	87.67^{ab}	7.76
NEUT (%)	22.33^{a}	16.17^{abc}	19.00^{ab}	12.33^{bc}	8.00

^{a,b,c} Means in the same row with different super script are significantly different.

white blood cell count values did not differ significantly ($p>0.05$) among the treatment groups and all the values. These indicate the normal body functions of hens and the absence of infection in all the treatment groups. This is in line with Awujiobi and Opia (2002), Ewuola *et al.* (2004) and Iheukwumere *et al.* (2008) who stated that haematological parameters are an index and reflection of the effects of dietary treatment on the animal in terms of type quality and quantity ingested to meet the physiological, biological, biochemical and metabolic necessities of the body. In this study, none of the haematological parameters evaluated had any adverse effect on the weaner pigs as well as meat production, and an indication that the dried cocoyam corn meal is an ideal feed ingredient and could replace maize in weaner pigs diets up to 20% level in their diets without any deleterious effect on the overall performance.

Conclusion

There was a significance difference ($p>0.05$) of cocoyam corn meal on the growth performance of weaner pigs. This implies that feeding weaner pigs with dried cocoyam corn meal *(Xanthosoma sagittifolium)* based diets improved feed intake, body weight gain, body weight and feed conversion efficiency. No significant differences ($p>0.05$) were observed on all blood profile parameters measured except the albumin and creatinine. The albumin and creatinine values ranged from 2.63-3.52 g/dl and 0.90-1.50 mg/dl respectively. It can be concluded that grower pigs fed 20% CCM based diet had a significant effect on the growth performance of pigs. The result also showed that there is no significant effect CCM based diet on their blood profile. Finally, the result of this study showed that 20% of cocoyam corn meal *(Xanthosoma sagittifolium)* could be included in the diets of weaner pigs without any adverse effects on the performance and blood parameters. It is therefore recommended that dry cocoyam corn meal (20%) should be encouraged in the feeding of pigs to reduce over dependence of maize feeds by our swine farmers and nutritionists which have led to high cost of raising monogastrics specifically pigs which thereby discouraged farmers from investing in the swine business.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Aboubakar, Njintang, Y. N. Scher, J., Mbofung, C. M. F. (2008). Physicochemical, thermal properties and microstructure of six varieties of taro (*Colocasia esculenta* L. Schott) flours and starches. *Journal of Food Engineering, 86*(2), 294-305.

Akinmutimi, A. H., Amaechi, N., & Unogu, M. (2006). Evaluation of raw African yam bean meal as substitute for soya bean meal in the diet of weaner rabbits. *Journal of Animal and Veterinary Advances*, *5(*11), 907-911.

AOAC (2010). Official Methods of Analysis (19th edition). Association of Official Analytical Chemists. Washington D.C. USA.

Awujiobi, H. A., & Opia, G. O. (2002). The effect of psychological status on some blood parameters of the Newzea Land White Doe Rabbits. Proceedings of 7th Annual Conference of Animal Science Association of Nigeria (ASAN), September 16th to 19th 2002, University of Agriculture, Abeokuta.

Anyaehie, A. A. (2017). Studies on exogenous enzyme supplementation of high fibre (maize- cob) soyabean based poultry diets: PhD Thesis, Imo State University, Owerri, Nigeria.

Dosumu, O. O., Oluwaniyi, O. O., Awolola, G. V., & Oyedeji, O. O. (2012). Nutritional composition and antimicrobial properties of three Nigerian condiments. *Nigerian Food Journal*, *30*(1), 43-52.

Duncan, D. B. (1955). Multiple range and multiple F tests. Biometrics, 11(1), 1-42.

Effiong, O. O., William, M. E., & Eyoh, G. D. (2015). Laying performance and egg quality evaluation of pullets fed diets

containing graded levels of processed Horse eye bean *(Mucuna urens)* meal. *Journal of Agriculture and Life Sciences, 2*(1), 140-145.
Esiegwu, A. C., & Okonkwo, V. N. (2018). Growth performance and blood indices of finisher pigs fed enzyme fortified (maxi-grain) rice milling waste. *Journal of Agriculture and Food Sciences, 16*(1), 24-32.
Esonu, B. O. (2000a). Animal nutrition and feeding: A functional approach. *Rukzeal and Rukson Association Memory Press, Owerri, Nigeria*.
Esonu, B. O. (2000b). Effect of dietary cooked wild variegated cocoyam (*Caladium hortulanum*) on the performance of broiler chickens. *Tropical agriculture*, *77*(4), 269-271.
Ewuola, E. O., Folayan, O. A., Gbore, F. A., Adebunmi, A. I., Akanji, R. A., Ogunlade, J. T., & Adeneye, J. A. (2004). Physiological response of growing west-African dwarf goats fed groundnut shell-based diets as the concentrate supplements. *Bowen Journal of Agriculture*, *1*(1), 61-66.
Eyasu, W., Tileye, T., & Kassahu, T. (2019). Proximate mineral and anti-nutrient contents of cocoyam *(Xanthosoma sagittifolium) (L.)* Schott. *International Journal of Food Science,* Volume 2019, Article ID 8965476, 7 pages.
FAO (2000). Food and Agricultural Organization, Statistical year book of world and agriculture on the state of food and agriculture. Rome Italy. 70p.
Hang, D. T., & Binh, L. V. (2013). Oxalate concentration in taro leaves and pentioles and effect of added calcium on nitrogen and calcium retention in pigs given diets containing 50% ensiled taro leaves and pentioles. *Livestock Research for Rural Development*, *25*(4). Retrieved from http://www.lrrd.org/lrrd25/4/hang25065.htm.
Iheukwumere, F. C., Ndubuisi, E. C., Mazi, E. A., & Onyekwere, M. U. (2008). Performance, nutrient utilization and organ characteristics of broilers fed cassava leaf meal (*Manihot esculenta* Crantz). *Pakistan Journal of nutrition*, *7*(1), 13-16.
Iwuoha, C. I., & Kalu, F. A. (1995). Calcium oxalate and physico-chemical properties of cocoyam (*Colocasia esculenta* and *Xanthosoma sagittifolium*) tuber flours as affected by processing. *Food Chemistry*, *54*(1), 61-66.
Matikiti, A., Allemann, J., Kujeke, G., Gasura, E., Masekesa, T., & Chabata, I. (2017). Nutritional composition of cocoyam (*Colocasia esculenta*), grown in manicaland province in Zimbabwe. *Asian Journal of Agriculture and Rural Development*, *7*(3), 48-55.
Merck Veterinary Manual (2016). Haematological reference ranges. Merck Manuals.
Ndimantang, B., Asinobi, C. O., & Obiakor, N. (2006). The effect of different processing methods on some anti-nutritional factors content of Ede uhie (*Xanthosoma sagittifolium*) and Ede ocha (*Colocasia esculenta*). *International Journal of Agriculture and Rural Development*, *7*(2), 7-14.
Noonan, S. N. (1999). Oxalate content of foods and its effect on humans. *Asia Pacific journal of clinical nutrition*, *8*(1), 64-74.
Obidinma, V. N. (2009). Brewer's dried grain as energy source in poultry production. A Ph.D Dissertation in Animal Production, Department of Animal Science and Fisheries, Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri-Nigeria
Okereke, C. O. (2012). Utilization of cassava, sweet potato, and cocoyam meals as dietary sources for poultry. *World Journal of Engineering and Pure & Applied Sciences*, *2*(2), 63-68.
Okonkwo, V. N. (2020). Performance of laying hens fed graded levels of dried yellow cocoyam corm meal (Xanthosoma sagittifolium) as partial replacement for maize. *Journal of Agriculture and Food Sciences*, *18*(1), 27-39.
Onu, P. N., & Madubuike, F. N. (2006). Effect of raw and cooked wild cocoyam (*Caladium bicolor*) on the performance of broiler chicks. *Agricultura Tropica et Subtropica*, *39*(4), 268-273.
Opara, L. U. (2003). Edible aroids post-harvest operation. In: *Post-harvest compendium*. Food and Agricultural Organization of the United Nations, Rome: Italy.
Owusu-Darko, P. G., Paterson, A., & Omenyo, E. L. (2014). Cocoyam (corms and cormels)—An underexploited food and feed resource. *Journal of Agricultural Chemistry and Environment*, *3*(1), 22-29.
Rao, V. R., Matthews, P. J., Eyzaguirre, P. B., & Hunter, D. (2010). The Global diversity of taro: Ethnobotany and conservation. Biodiversity International, Rome Italy.
SAS (2002). Statistical Analysis System SAS 9.1 for Windows. SAS Institute Inc. Cary, NC.
Sefa-Dedeh, S., & Agyir-Sackey, E. K. (2004). Chemical composition and the effect of processing on oxalate content of cocoyam *Xanthosoma sagittifolium* and *Colocasia esculenta* cormels. *Food chemistry*, *85*(4), 479-487.
Singh, V., Tyagi, P. K., Tyagi, P. K., Mandal, A. B., & Singh, S. (2013). Reducing egg cholesterol through dietary addition of ginger and garlic in quails. *Indian Journal of Poultry Science*, *48*(3), 306-312.
Subhash, C., Sarla, S., & Jaybardhan, S. (2012). Phytochemical screening of *Garhwal himalaya* wild edible tuber *Colocasia esculenta*. *International Research Journal of Pharmacy*, *3*(3), 181-186.
Zhu, F. (2016). Buckwheat starch: Structures, properties, and applications. *Trends in Food Science & Technology*, *49*, 121-135.