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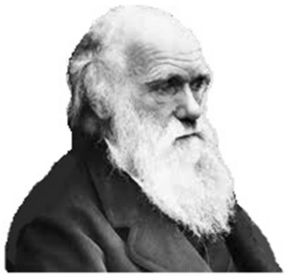

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Evaluation of selected agricultural wastes as viable sources of vitamin supplements in poultry feeds

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ABSTRACT

The vitamin content of selected agricultural wastes was evaluated as supplements in poultry feeds. The agricultural wastes considered in this study include; cassava bagasse, beans coat, pineapple peel, avocado pear seed, watermelon peel, fluted pumpkin stalk, potato peel, Mix. A - mixture of all wastes (ratio, 1:1:1), Mix. B - mixture of bean jackets, avocado pear seed and potato peel (ratio, 1:1:1). The vitamins considered were Vitamin A, Vitamin D, Vitamin $B_{12,}$ Vitamin E, Vitamin K, Pantothenic acid, Niacin, Biotin and Pyridoxine. Cassava bagasse gave the highest amount of vitamin A (0.36±0.06 mg/l), whereas this vitamin was totally absent in fluted pumpkin stalk. This waste also gave the highest amount of vitamin E (0.99±0.21 mg/l). The highest amount of vitamin D (10.35±0.21 mg/l) was obtained from watermelon peel, while the highest amount of vitamin B_{12} (0.08±0.04 mg/l) was gleaned from a mixture of all the wastes (Mix. A). The wastes were quite low in vitamin K - herein, Mix. B (bean jackets, avocado pear seed, and potato peel) gave the highest amount (2.36±0.16 mg/l). Finally, pineapple peel gave the highest amount of pantothenic acid (8.55±0.35 mg/l), niacin (5.95±0.53 mg/l), biotin (0.08±0.03 mg/l), as well as pyridoxine (2.45±0.55 mg/l). These results were compared with the standards required for feed formulation for different categories of poultry birds. Our findings revealed that these agro-wastes contain vitamin levels that did not differ significantly from the standards required for feed formulation for different categories of poultry birds. Hence, they can serve as good supplements for vitamins in poultry feeds. Harnessing the vitamin contents of these wastes as supplements in poultry feed will increase animal production and ensure food security in terms of protein supply.

***Keywords*:** agricultural wastes, vitamins, poultry feeds

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1. INTRODUCTION

Feed additive are extensively used to increase animal performance, and till date, they are widely used in poultry feeding practices [1, 2] to improve growth feed efficiency as well as improving the performance and wellbeing of birds [3, 4]. Previously, many agricultural crops were used in poultry feed to prevent disease, improve growth performance, and increase output of birds. [5a,b] also reported that addition of herbal products in diets of poultry and swine showed growth promoting effects. However, owing to the increasing cost of animal feed, attention is shifting to alternative feed sources. Many agricultural crops have been considered for this purpose [6, 7]. The competition between human beings and animals for agricultural crops has moved researchers to exploit agricultural wastes for their nutrient contents.

Vitamins, a group of complex organic compounds that are present in minute amounts in natural foodstuffs, are essential for normal metabolism, and a lack of these compounds in the diet causes deficiency diseases. The term “vitamin” or “vitamine” was coined less than 100 years ago, in 1912, by a Polish biochemist Casimur Funk. Till date, 15 vitamins have been identified and classified as either fat- or water-soluble. The number of compounds that can justifiably be classified as vitamins is controversial. The term “vitamin” has been applied to many substances that do not meet the criteria used to define vitamins [8, 9].

Some vitamins deviate from the above definition in that they do not always need to be constituents of food. Certain substances considered to be vitamins are synthesized by intestinal tract bacteria in quantities that are often adequate for bodily needs. However, a clear distinction is made between vitamins and substances that are synthesized in body tissues. Usually, choline is only tentatively classified as one of the B-complex vitamins. It differs from the other B vitamins in that it can be synthesized in the body, it is required in larger amounts and it apparently functions as a structural constituent rather than as a coenzyme [8]. Similarly, carnitine was tentatively classified as a vitamin, but this applies to only a few species under special circumstances. Vitamin C can be synthesized by most animal species, except when they are young or under stress conditions. Likewise, in most species, niacin can be synthesized from the amino acid tryptophan and vitamin D from the action of ultraviolet light on precursor compounds in the skin. Thus, under certain conditions and for specific species, vitamin C, niacin and vitamin D do not always fit the classic definition of a vitamin.

Vitamin D nonetheless fits the vitamin definition for cats and dogs, which lack skin receptors for this vitamin, as well as for poultry and swine that are raised under management systems that exclude exposure to ultraviolet light [10]. The major functions of the B-vitamins have been known for many years. There is now a clearer picture of the metabolism and functions of vitamins A, D, E, K and C. For instance, vitamins A and D with hormone functions are both considered to play as equally important roles as do thyroid hormones. It has been determined that the functions of vitamins K and D are not limited to blood clotting and bone formation, respectively [11]. Vitamin C, which is synthesized by most species, may nonetheless be beneficial when provided to animals under stress. Deficiencies do occur under special conditions and supplementation has proven beneficial in the case of thiamin, niacin, vitamin B12, choline, biotin and vitamin K. Classical deficiency symptoms and non-specific parameters (e.g. lower production and reproduction rates) are associated with vitamin deficiencies or excesses. Vitamin nutrition should no longer be considered important solely for preventing deficiency signs since they play a role in optimizing animal health (e.g.

immune function), productivity and product quality. Vitamins are required in trace amounts (micrograms to milligrams per day) in the diet for health, growth, and reproduction. Omission of a single vitamin from the diet of an animal specie that requires it will produce deficiency signs and symptoms. Many of the vitamins function as coenzymes (metabolic catalysts), others perform other essential functions.

Vitamins originate primarily in plant tissues and are present in animal tissue only because the animal has ingested plant material, or because it harbours microorganisms that synthesize them. Vitamin B12 is unique in that it occurs in plant tissues as a result of microbial synthesis. Two of the four fat-soluble vitamins, vitamins A and D, differ from the water-soluble B vitamins in that they occur in plant tissue as a provitamin (a precursor of the vitamin), which can be converted to a vitamin in the animal body. No provitamins have been identified for any of the water-soluble vitamins. In addition, fat- and water-soluble vitamins differ in that water-soluble B- vitamins are universally distributed in all living tissues, whereas fat-soluble vitamins are completely absent from some tissues.

Poultry under intensive production systems are particularly susceptible to vitamin deficiencies. The reasons for this is not far-fetched and may include the fact that poultry derives little or no benefit from microbial synthesis of vitamins in the gastrointestinal tract and the high density concentration of modern poultry operations places a lot of stress on the birds which could increase their vitamin requirements. Typical grain-oilseed meal (e.g., corn-soybean meal) poultry diets are generally supplemented with vitamins A, D (D3), E, K, riboflavin, niacin, pantothenic acid, B12 and choline [11]. However, adding other vitamins to poultry diets guarantees good health. Vitamins D and B12 are almost completely absent from diets based on corn and soybean meal. Vitamin K is generally added to poultry diets more than the diets of other species because of the lower level of intestinal synthesis that occurs in birds due to their shorter intestinal tract and the faster rate of food passage.

The by- products of agricultural activities, usually referred to as agricultural wastes because they are not the primary products have continued to be converted into other usable forms. These wastes exist in different forms like stalks, straw, leaves, roots, husks, peels etc and animal wastes. These wastes are readily available, renewable, and virtually free, hence they can be an important resource [12]. They can be converted into energy as well as animal feed. However most of these wastes are under-utilized or left to rot or openly burnt especially in developing countries. These wastes are known to contain high nutrient levels like nitrogen, potassium, phosphorus that can increase soil fertility and crop yield or used as animal feed thereby enhancing food security.

Both crop residues and animal wastes can be used as animal feed. However the nutrient content of these wastes depends on the animal species and type of feed [13]. The use of broiler litter in cattle feeding is a widely applied practice. Animals, especially ruminants are useful in converting crop residues into food, hence contributing substantially to reduction of potential pollutants. The rumen contains the microbial enzyme cellulase, which commonly degrades the plant product, cellulose [14, 15]. With the ruminants, nutrients in by-products are utilized rather than become a waste-disposal problem [16].

The use of agricultural by-products in animal feed holds tremendous potential in alleviating the existing critical situation of high cost and inadequate supply of feed [17]. Several animal nutritionists have utililized these agricultural wastes in feed formulation for different animals. Some of these include cassava peels in rabbit [18], cassava in layers and growers mash [19]. However, the fibrousness of these agricultural wastes has been identified as a major cause of under utilization for animal feeding [20]. Considerable efforts have been made to improve the utilization of agricultural wastes in practical animal nutrition. Methods employed in improving fibre utililization include cooking and autoclaving [21] and steam treatment [22]. Microbial enzymes and antibiotics have also been employed [23]. An example of agricultural waste used in animal feeding is beans husk or hull.

Studies have shown that many unconventional feedstuffs including agricultural by- and waste products can serve as viable alternatives to traditional ingredients of poultry diets [24]. One objective of such studies is to identify feedstuffs that are not directly utilized by humans to avoid competition between humans and livestock for food sources [25]. Another important incentive is to find ways of utilizing agricultural wastes products and residues. These products tend to accumulate with the concomitant cost of disposing of them, and managing them to limit environmental pollution [26].

However these products frequently contain anti-nutritional components such as condensed tannins, saponins and non- starch polysaccharides which most monogastric livestock are incapable of digesting [27]. In addition, these products might contain toxic substances such as cyanogenic glycoside in cassava [28]. For instance, Avocado meal is a waste product consisting of oil- extracted avocado fruits that were unsuitable for the fruit market. The residue is considered a waste product that creates a disposal problem. From the chemical composition, it seems to be a potential feedstuff for animals, specifically as an energy source [29]. In integrated fish farming also, many agricultural wastes are being used. This system of farming has been proposed as an environmentally friendly way of recycling wastes, especially those produced through the cultivation of high trophic level fish species which require the supply of exogenous energy [30]. Re-using agricultural wastes helps to solve the problem of waste disposal and scarcity of resource materials. According to [31], pig, poultry and duck production have also been boosted using agricultural wastes. Aquaculture has recycled agricultural wastes for centuries with the aim of boosting pond productivity of plants and animals [32].

2. MATERIALS AND METHODS

Sample collection and processing

The agricultural wastes used in this study were all sourced from household kitchen-wastes. Cassava bagasse was collected after processing some cassava tubers. The other wastes- yam peel, potato peel, pineapple peel, watermelon peel, beans coat, avocado pear seed and fluted pumpkin stalk were collected from kitchen wastes, sorted, washed with distilled water to remove sand and dirts and cut into pieces before sun-drying. The samples were sun-dried for two weeks with constant turning to ensure proper drying. Samples were then milled into powdered form using a milling machine. Samples were then sieved using a 500 µm sieve in order to get a smooth sample of uniform size. They were then stored in properly washed, dried and labeled containers for further analyses.

Vitamin content determination

Vitamins A and B3 (Niacin) were determined as described by [33].

Vitamin A determination

Vitamin A was determined through ultraviolet absorption measurement at 328 nm after extraction with chloroform. Calibration curve of vitamin A acetate was made and sample vitamin A concentration estimated as microgram (μg) of vitamin A acetate.

Vitamin B_3 (niacin) determination

5g of blended sample was extracted with 100 ml of distilled water. Then 5ml of this solution was drawn into 100 ml volumetric flask and made up to mark with distilled water. Standard solutions of niacin were prepared and absorbance of sample and standard solutions were measured at a wavelength of 385 nm on a spectrophotometer and niacin concentration of the sample estimated.

Other vitamins, D, B_5 (panthotenic acid), B_6 (pyridoxine), B_7 (biotin), B_{12} (cobalamine), E, and K were determined as follows:

Procedure: 100 mg of each powdered agro-waste was weighed into a 50 ml volumetric flask. 20ml of mobile phase sample was added into the flask and shaken vigorously until it dissolved. It was made up to mark of 50 ml with same mobile phase. The sample was then filtered using a vacuum filter with membrane filter incorporated. Filtrate was sonicated using a sonicator for about 30 minutes, the mobile phase was also sonicated.

The High Powered Liquid Chromatography (HPLC) system was switched on and allowed to warm up and a standard vitamin of known concentration was injected into it. The equipment was purged with the mobile phase of the vitamin to be determined and 20 microlitre of the filtrate was injected using the HPLC syringe into the HPLC system. Samples were then analyzed and quantified automatically with reference to the standard.

This procedure was same for all the vitamins but the mobile phase of each vitamin was the solvent for dissolving the sample.

Statistical Analysis

Data were obtained in triplicates and results were presented as mean± standard deviation. Results were subjected to statistical analysis using Chi-square (X^2) test. A P-value of <0.05 was considered significant.

3. RESULTS AND DISCUSSION

Table 1. Results of Vitamin content of the agro-waste samples (mg/l)

Vitamins (mg/l)	CB	B/C	Pin.P	APS	WMP	FPS	Pot.P	Mix.A	Mix.B
Vitamin A	0.36 ±0.06	0.20 ±0.02	0.18 ±0.03	0.15 ±0.01	0.19 ±0.04	0.00	0.24 ±0.03	0.17 ±0.05	0.20 ±0.02
Vitamin D	1.24 ±0.14	3.55 ±0.12	9.80 ±0.48	6.53 ±0.14	10.35 ±0.21	8.60 ±0.19	0.33 ±0.04	1.85 ±0.52	2.05 ±0.13

Vitamin B_{12}	0.01 ±0.01	0.05 ±0.01	0.07 ±0.01	0.06 ±0.02	0.03 ±0.01	0.00	0.04 ±0.01	0.08 ±0.04	0.05 ±0.02
Panthotenic acid mg	3.80 ±0.45	4.58 ±0.38	8.55 ±0.35	4.32 ±0.10	7.21 ±0.39	4.33 ±0.47	5.43 ±0.21	5.21 ±0.29	4.31 ±0.17
Niacin mg	3.71 ±0.91	4.68 ±0.28	5.93 ±0.53	2.35 ±0.15	3.84 ±0.13	1.01 ±0.01	3.25 ±0.20	4.48 ±0.23	2.45 ±0.13
Vitamin E	0.99 ±0.21	0.13 ±0.02	0.11 ±0.08	0.64 ±0.07	0.81 0.02	0.10 ±0.06	0.45 ±0.13	0.71 ±0.18	0.38 ±0.07
Vitamin K	0.00	2.60 ±0.01	0.00	2.47 ±0.04	0.00	0.00	1.80 ±0.02	0.00	2.36 ±0.16
Biotin	0.00	0.05 ±0.03	0.08 ±0.03	0.10 ±0.03	0.03 ±0.02	0.02 ±0.01	0.02 ±0.02	0.03 ±0.01	0.04 ±0.02
Pyridoxine	0.41 ±0.12	2.45 ±0.55	2.40 ±0.28	1.80 ±0.45	0.72 ±0.18	1.24 ±0.41	0.55 ±0.21	2.13 ±0.12	2.06 ±0.05

Values are mean ± standard deviations of triplicate determinations.

CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes excluding yam peel, (ratio, 1:1:1), Mix.B = Mixture of beans coat, avocado pear seed and potato peel (ratio, 1:1:1).

The different agro-wastes yielded varying amounts of vitamins and the results obtained were compared with the standards that are required for feed formulation for different types of poultry birds to know the difference.

Table 2. Comparison between Vitamin A (I.U) requirements for poultry birds at different stages of growth and that from the various agricultural wastes

Poultry Birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Vit.A requirements	5000	3500	4000	5000	3500	4000	4000	4000	4000	4000
CB	0.36***	0.36***	0.36***	0.36***	0.36***	0.36***	0.36***	0.36***	0.36***	0.36***
Pot.P	0.24***	0.24***	0.24***	0.24***	0.24***	0.24***	0.24***	0.24***	0.24***	0.24***
Pin.P	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***
BC	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***

APS	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***
WMP	0.19***	0.19***	0.19***	0.19***	0.19***	0.19***	0.19***	0.19***	0.19***	0.19***
FPS	0***	0***	0***	0***	0***	0***	0***	0***	0***	0***
MixA	0.17***	0.17***	0.17***	0.17***	0.17***	0.17***	0.17***	0.17***	0.17***	0.17***
MixB	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***	0.2***

***** = values obtained were very highly significant at p=0.001 when compared with standards;** CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

Table 3. Comparison between Vitamin D (I.U) requirements for poultry birds at different stages of growth and that from the various agricultural wastes

Poultry Birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Vit. D requirements	5000	3500	5000	5000	3000	850	850	850	850	850
CB	1.24***	1.24***	1.24***	1.24***	1.24***	1.24***	1.24***	1.24***	1.24***	1.24***
Pot.P	0.33***	0.33***	0.33***	0.33***	0.33***	0.33***	0.33***	0.33***	0.33***	0.33***
Pin.P	9.8***	9.8***	9.8***	9.8***	9.8***	9.8***	9.8***	9.8***	9.8***	9.8***
BC	3.55***	3.55***	3.55***	3.55***	3.55***	3.55***	3.55***	3.55***	3.55***	3.55***
APS	6.53***	6.53***	6.53***	6.53***	6.53***	6.53***	6.53***	6.53***	6.53***	6.53***
WMP	10.35***	10.35***	10.35***	10.35***	10.35***	10.35***	10.35***	10.35***	10.35***	10.35***
FPS	8.6***	8.6***	8.6***	8.6***	8.6***	8.6***	8.6***	8.6***	8.6***	8.6***
MixA	1.85***	1.85***	1.85***	1.85***	1.85***	1.85***	1.85***	1.85***	1.85***	1.85***
MixB	2.05***	2.05***	2.05***	2.05***	2.05***	2.05***	2.05***	2.05***	2.05***	2.05***

***** = values obtained were very highly significant at p=0.001 when compared with standards;** CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

Table 4. Comparison between Vitamin B_{12} (mg) requirements for poultry birds at different stages of growth and that from the various agricultural wastes.

Poultry birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Vit. B_{12} Requirements	0.005	0.003	0.003	0.005	0.003	0.005	0.005	0.003	0.003	0.003
CB	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Pot.P	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Pin.P	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
BC	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
APS	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
WMP	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
FPS	0	0	0	0	0	0	0	0	0	0
MixA	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
MixB	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Value obtained were not significant at p=0.05 when compared with required standards; CB = Cassava bagasse, BC = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

Table 5. Comparison between Panthotenic acid (mg) requirements for poultry birds at different stages of growth and that from the various agricultural wastes

Poultry Birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Panthotenic acid requirements	6.5	6	3	6.5	6	10	10	9	8.5	12
CB	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8*
PotP	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43
PinP	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
BC	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
APS	4.32	4.32	4.32	4.32	4.32	4.32	4.32	4.32	4.32	4.32
WMP	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21
FPS	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33
MixA	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21
MixB	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31

Values without asterix did not differ significantly (p=0.05) from the standards; CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

Table 6. Comparison between Niacin (mg) requirements for poultry birds at different stages of growth and that from the various agricultural wastes

Poultry Birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Niacin requirements	18	15	12	18	16	70	70	60	50	30

CB	3.71**	3.71*	3.71*	3.71**	3.71*	3.71***	3.71***	3.71***	3.71***	3.71***
PotP	3.25**	3.25*	3.25*	3.25**	3.25**	3.25***	3.25***	3.25***	3.25***	3.25***
PinP	5.93*	5.93*	5.93	5.93*	5.93*	5.93***	5.93***	5.93***	5.93***	5.93***
BC	4.68*	4.68*	4.68	4.68*	4.68*	4.68***	4.68***	4.68***	4.68***	4.68***
APS	2.35**	2.35*	2.35*	2.35**	2.35**	2.35***	2.35***	2.35***	2.35***	2.35***
WMP	3.84**	3.84*	3.84*	3.84**	3.84*	3.84***	3.84***	3.84***	3.84***	3.84***
FPS	1.01***	1.01***	1.01**	1.01***	1.01***	1.01***	1.01***	1.01***	1.01***	1.01***
MixA	4.48*	4.48*	4.48 ^{NS}	4.48*	4.48*	4.48***	4.48***	4.48***	4.48***	4.48***
MixB	2.45**	2.45**	2.45*	2.45**	2.45**	2.45***	2.45***	2.45***	2.45***	2.45***

***** = Very highly significant at p = 0.001; ** = highly significant at p = 0.01; * = significant at p = 0.05;**
CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

Table 7. Comparison between Vitamin E- requirements for poultry birds at different stages of growth and that from the various agricultural wastes

Poultry birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Vitamin E requirements	5	4	4	5	4	12	12	10.5	10	20
CB	0.99	0.99	0.99	0.99	0.99	0.99**	0.99**	0.99**	0.99**	0.99***
PotP	0.4	0.45	0.45	0.45	0.45	0.45***	0.45***	0.45**	0.45**	0.45***
PinP	0.11*	0.11	0.11	0.11*	0.11	0.11***	0.11***	0.11***	0.11***	0.11***
BC	0.13*	0.1	0.13	0.13*	0.13	0.13***	0.13***	0.13***	0.13***	0.13***

APS	0.64	0.64	0.64	0.64	0.64	0.64***	0.64***	0.64**	0.64**	0.64***
WMP	0.81	0.81	0.81	0.81	0.81	0.81***	0.81***	0.81**	0.81**	0.81***
FPS	0.1*	0.1*	0.1*	0.1*	0.1*	0.1***	0.1***	0.1***	0.1***	0.1***
MixA	0.71	0.71	0.71	0.71	0.71	0.71***	0.71***	0.71**	0.71**	0.71***
MixB	0.38*	0.38	0.38	0.38*	0.38	0.38***	0.38***	0.38***	0.38***	0.38***

***** = Very highly significant at p=0.001; ** = highly significant at p = 0.01; * = significant at p=0.05; figures without asterix are not significant at p = 0.05;** CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

Table 8. Comparison between Vitamin K- requirements for poultry birds at different stages of growth and that from the various agricultural wastes

Poultry birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Vitamin K requirements	2.5	2.5	2.5	2.5	2.5	2	1.5	1	0.8	1
CB	0	0	0	0	0	0	0	0	0	0
PotP	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
PinP	0	0	0	0	0	0	0	0	0	0
BC	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
APS	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47
WMP	0	0	0	0	0	0	0	0	0	0
FPS	0	0	0	0	0	0	0	0	0	0
MixA	0	0	0	0	0	0	0	0	0	0
MixB	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36

Values obtained did not differ significantly (p=0.05) from the standards;
CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

Table 9. Comparison between Biotin (mg) - requirements for poultry birds at different stages of growth and that from the various agricultural wastes

Poultry birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Biotin requirements	0.08	0.05	0.08	0.05	0.2	0.2	0.2	0.1	0.1	0.15
CB	0	0	0	0	0	0	0	0	0	0
PotP	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Pin.P	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
BC	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
APS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
WMP	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
FPS	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
MixA	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
MixB	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Values obtained did not differ significantly at p = 0.05 with the standards;
CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

Table 10. Comparison between Pyridoxine (mg) requirements for poultry birds at different stages of growth and that from the various agricultural wastes

Poultry Birds at different stages of growth	Chick Ration	Growers Ration	Layers Ration	Broiler Starter	Broiler Finisher	Turkey Prestarter	Turkey Starter	Turkey Grower1	Turkey Grower2	Turkey Finisher
Standard Pyridoxine requirements	2	1.5	1.5	2.5	1.5	2	2	2.5	2.5	2
CB	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
PotP	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
PinP	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
BC	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
APS	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
WMP	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
FPS	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
MixA	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13
MixB	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06

Values without asterix are not significant at p=0.05 compared with the standard requirements;
CB = Cassava bagasse, B/C = Beans coat, Pin.P = Pineapple peel, APS = Avocado pear seed, WMP = Watermelon peel, FPS = Fluted pumpkin stalk, Pot.P = potato peel, Mix. A = mixture of all wastes, Mix.B = Mixture of beans coat, avocado pear seed and potato peel

4. DISCUSSION

From the results obtained, Cassava bagasse gave the highest amount of vitamin A (0.36±0.06 mg/l) whereas this vitamin was totally absent in fluted pumpkin stalk. The highest value obtained for this vitamin was far below the standards required for feed formulation in all the poultry species considered in the study. Vitamin A is necessary for the support of growth, health and general well being of animals [34]. In the absence of vitamin A, the animal will cease to grow and eventually die. Absence of this vitamin in poultry species causes loss of vision due to a failure of rhodopsin formation in the retina, low resistance to diseases, defects in bone growth, defects in reproduction and defects in growth and differentiation of epithelial tissues, frequently resulting in keratinization [35]. As deficiency progresses in adult poultry, the chickens become emanciated, weak and their feathers are ruffled. There is also decrease in egg production. This waste (CB) also gave the highest amount of vitamin E (0.99±0.21 mg/l). Vitamin E is essential for the integrity and optimum function of the reproductive, muscular, circulatory, nervous and immune systems [36]. The highest amount of vitamin D (10.35±0.21 mg/l) was from watermelon peel. This vitamin functions in elevating plasma Ca and P to a level that will support normal mineralization of bones as well as other body functions. Deficiency in chickens causes rickets which is characterized by severe weakness of the legs [37]. A mixture of all the wastes (mixture A) gave the highest amount of vitamin B_{12} (0.08±0.04 mg/l).

The importance of this vitamin in poultry feed cannot be overemphasized. It is an essential part of several enzyme systems that carry out a number of very basic metabolic functions. In growing chicks, turkey and quail, vitamin B_{12} deficiency reduces body weight gain, feed intake and feed conversion [38]. The wastes were quite low in vitamin K and mixture B (beans coat, avocado pear seed, and potato peel) gave the highest amount (2.36±0.16 mg/l). vitamin K is important in the coagulation of blood, its deficiency causes a reduction in the prothrombin content of the blood and in the chick, it may reduce the quantity in the plasma to less than 2% of normal [11]. Pineapple peel gave the highest amount of panthotenic acid (8.55±0.35 mg/l), niacin (5.95±0.53 mg/l), biotin (0.08±0.03 mg/l) as well as pyridoxine (2.45±0.55 mg/l). Deficiency of panthotenic acid reduces normal egg production and hatchability. Niacin is known for its role in physiological functions through its role in enzyme systems for cell respiration, while biotin is important for normal function of the thyroid and adrenal glands. Its deficiency causes general reduction in growth rate, loose feathers and disorders on the legs [11]. Poultry species fed with pyridoxine deficient diets have little appetite and grow slowly, with plumage failing to fully develop [38].

The quantities of vitamin A, D and Niacin in the agro-wastes were lower than the quantities required by different classes of birds (tables 2.0, 3.0 and 6.0 respectively). The values obtained for vitamin B_{12}, panthotenic acid, pyridoxine, vitamin K, and biotin, did not differ significantly at 95% confidence level from the standard requirements for all the categories of birds as seen in tables 4.0, 5.0, 8.0, 9.0 and 10.0 respectively. Values obtained for vitamins A and D were very highly significantly different at 99.9% confidence level when compared with the standard values required by the birds. For niacin, the values differed at different confidence levels. The values of vitamin E obtained from the waste samples differed significantly from the standard requirements at different confidence levels. The highest value obtained for vitamin E was 0.99mg/l for cassava bagasse and this did not differ significantly at 95% confidence level from most of the standard requirements for the birds. It however differed very significantly at 99% confidence level from the highest value (20%) required for standard feed for turkey finisher as seen in table 7.0.

Vitamins are indispensable for the growth and maintenance of birds. In most cases, these vitamins cannot be synthesized by the animals so they have to be introduced to the animal [39]. They act as biological catalysts, for instance, if Vitamin A is deficient in poultry feed, the mortality rate is usually high. Early symptoms include retarded growth, weakness, roughened plumage. In adult birds, egg production and hatchability are reduced [39].

5. CONCLUSIONS

This study focused on the exploitation of selected agricultural wastes for their vitamin contents in order to determine their suitability for replacing or supplementing the vitamin needs in poultry feeds. For some of the wastes, the vitamin contents were able to meet the standard requirement for feed formulation for different types of poultry birds. It was therefore concluded that since most of these nutrients did not differ significantly from the standard requirements of the poultry birds, they can therefore serve as supplements to the traditional ingredients used in formulating poultry feeds. This will help in reducing the cost implication involved in conventional feeds. Since various vitamins can be obtained from these agro-wastes, their use in poultry feed is therefore encouraged. Utilizing these wastes for the production of other valuable products like animal feed will help to increase animal production and ensure food security in terms of protein supply. It will also help in getting our environment rid of these wastes thereby ensuring environmental sustainability.

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