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EFFECT OF DIFFERENTLY PROCESSED COMPOSITE ORANGE PEEL DIETS ON PERFORMANCE OF EWE-LAMB AND MILK COMPOSITION OF WEST AFRICAN DWARF EWES

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ABSTRACT

Supplementation of agro-industrial by-products to improve ruminant production both in quantity and quality during period of feed scarcity is important for maintenance and increased productivity. This study investigated the performance of ewe-lamb and milk composition of West African Dwarf (WAD) ewe fed differently processed orange peel diets. The oestrus cycle of ewes was synchronized with prostaglandin injection. Milk collection was done after lambing for 12 weeks. The treatment were; control diet (0% OP), 15% unfermented orange peels (15% UFOP) and 15% fermented orange (15% FOP). Twenty-four (24) ewes with average weight of 14.27±0.47 kg was allotted to three treatment groups in a Completely Randomized Design. The experiment investigated the phytochemical, ewe-lamb performance, milk composition and milk yield of WAD dams fed UFOP and FOP diets. Data collected were analyzed using One-way Analysis of Variance. Results revealed that tannin, oxalate and saponin in FOP were 23.80 g/kg, 201.20 g/kg and 73.10 g/kg while 14.50 g/kg, 164.50 g/kg and 45.60 g/kg for UFOP. Weaning weight, weight gain and daily weight gain decreased ($p<0.05$) in lambs fed 15% UFOP and 15% FOP supplementation compared to the control. Partial milk yield increased ($p<0.05$) in 0% OP compared to the other treatment groups. Lactose, protein, milk density and solid particle were elevated ($p<0.05$) in 15% UFOP supplementation. The study concluded that supplementation of 15% UFOP and 15% FOP improved ewe-lamb weight, chemical properties of milk.

Keywords: Ewe, Milk composition, Orange peels, Phytochemical

INTRODUCTION

The tropics' population's nutritional status is primarily defined by insufficient protein intake, both in quantity and quality, which has resulted in an increase in demand for meat, milk, and its products, necessitating the need to increase their productivity. The traditional dairy sub-sector, on the other hand, is dominated by indigenous cattle breeds, and the milk production potential of small ruminants (sheep and goats) is largely untapped (Olorunisomo, 2013). To close the gap between low protein intake and high-quality ruminant output in terms of meat and milk products, their productivity and reproduction must be well managed.

Thus, for the majority of animal nutritionists and livestock farmers, the search for alternative feed ingredients becomes critical. This has resulted in the identification and evaluation of a variety of agro-industrial by-products (mango reject, citrus molasses, citrus peels, sugarcane beet and sugarcane peels), browse plants, and other evergreen tree species as a means of addressing seasonal pasture shortages in terms of both quality and quantity (Arigbede *et al*., 2010). According to research, these alternative feed sources have a high nutritional value in terms of crude protein, vitamins, minerals, and antioxidants, making them excellent candidates for replacing highly conventional feedstuffs in livestock production that are highly competitive and more expensive (Oluremi *et al*., 2007).

Typically, wastes from agricultural products (by-products) pose a threat to the environment, clogging waterways, polluting the environment, and accumulating ammonia, all of which have detrimental effects on human health. This results in the release of odour, which serves as a breeding ground for insects and generally creates an unsightly environment with a diminished aesthetic appeal. When this material is not processed, it becomes a very concerning situation and a source of environmental concern, which can eventually result in environmental pollution (Mandalari *et al*., 2006; Hegazy and Ibrahim, 2012). On the other hand, waste that has been properly processed can be used as valuable feed resources in livestock production.

Citrus fruit waste (citrus pulp and peel, for example) has been shown to be a good source of Vitamin C, fiber, and a variety of other constituents (phenolics, flavonoids, and essential oils) that act as antioxidants. Antioxidants are a broad term that refers to any substance that delays, prevents, or eliminates oxidative damage to target molecules (Halliwell, 2007). As a result, Ipinjolu (2000) suggests that instead of discarding orange peels, they can be processed to produce orange peel meal. Additionally, orange peel has been reported to have a relatively high Crude Protein (CP) content of 9.30-10.96 percent and a Nitrogen Free Extract content of 65.30-67.95 percent (Oluremi *et al*., 2007), whereas Orayaga (2010) reported a CP content of 7.22 percent and an NFE content of 74.84 percent. Orange fruit rind (peel) meal has been found to be a comparable source of calories and protein to maize (Oluremi *et al*., 2006). McDonald *et al*. (1995) noted that the majority of these unconventional feedstuffs have a low utilization rate due to their high fiber content and phytochemicals or toxic compounds. Oluremi *et al*. (2007), on the other hand, reported that the antinutrient content of citrus (tannin, saponin, oxalate, flavonoid, and limonene) is within the safe range for ruminant health; they did, however, recommend different processing methods (sun-drying and fermentation) to further reduce the antinutrient content of citrus peel (Oluremi *et al*., 2007; Orayaga, 2010; Oyewole, 2011). Interestingly, fermented orange peel meal has been used to replace maize offal in goat diets up to 80% without compromising performance or blood indices (Oloche *et al*., 2018). Shittu *et al*. (2018) observed a similar trend in Bunaji bulls when sun dried sweet orange peels were substituted up to 75% without affecting performance or blood profile. As a result, the majority of research on the performance of West African Dwarf bucks, Red Sokoto bucks, and Bunaji bulls has demonstrated that orange peels can be included in their diets without causing harm. However, the presence of essential oils and flavonoids in the peels may aid in reducing the reaction of reactive oxygen species in the animal while preserving the milk due to the peels' high antioxidant content. Thus, the effects of differently processed orange peels on the performance of ewe-lamb and milk composition of West African Dwarf ewes were evaluated in this study.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Small Ruminant Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun state. The site is located in the rain forest vegetation zone of South-western Nigeria on Latitude 7º 13´ 49.46´´N, Longitude 3⁰ 26´ 11.98´´E and altitude 76m above the sea level (Google Earth, 2019). The climate is humid with a mean annual rainfall of 1037mm and mean temperature and humidity of 34.7ºC and 83%, respectively (Nimet, 2019).

Ethical approval

The experimental design and plan of the study strictly followed the lay down guideline of the postgraduate ethics committee on research in the College of Animal Science; University of Agriculture Abeokuta, Ogun state. Nigeria

Test ingredient collection and processing

Sweet orange peels were collected from orange fruit retail sellers around Abeokuta and its environs. The peels were divided into two parts; one part was sundried till crispy to touch, crushed with hammer mill and bulked as unfermented orange peels (UFOP) for later use. The UFOP was mixed with other ingredients to form concentrate diet. Also, the second part was fermented by placing in a tight polythene bag, compressed, sealed and allowed to ferment for 48hrs. This was then sun dried till crispy to touch and crushed with hammer mill to form meal tagged fermented peel (FOP). Both UFOP and FOP were kept in an air tight bag for further use. The UFOP and FOP were mixed separately with other ingredients like palm kernel cake, soya bean meal, maize, maize offal, salt and bone meal to form three experimental concentrates containing 0% OP (T1, Control), 15% of UFOP (T2, UFOPM) and 15% FOP (T3, FOPM) as shown in Table 1.

Chemical and phytochemical screening of orange peels

Phytochemical screening (alkaloid, saponin, glucoside, tannin and flavonoids) of UFOP and FOP samples were carried out in the laboratory as described by Soforowa, (1993), while chemical composition of feed samples was carried out to determine the dry matter content, protein, ash, fat, fibre fractions and carbohydrate content according to AOAC (2005) procedures.

Experimental design

The twenty four (24) WAD sheep were divided into three groups containing eight (8) animals per group after weight equalization. Each group was randomly allotted to one of the three experimental diets in a completely randomized design. Each animal serves as a replicate. The ewes were fed concentrate feed at 09:00hr and cut and carry grass (*Panicum maximum*) at 16:00hr. Water was also provided *ad-libitum*. The experiment lasted for 70 days.

Data collection

Records on the reproductive performance of WAD ewes were evaluated. Parameters determined include gestation length, abortion rate, litter size, birth weight, post-partum weight and lamb weight gain.

Determination of milk yield and chemical analysis of milk

The udders were washed with warm water with hand towel so as to prevent dirt and microbial contamination of the milk. Milking was carried out by gently stripping the udder teats to obtain the milk in the udder into clean sterile bottles until there was no milk. These were collected weekly throughout the lactating period. Milk yield was measured with the aid of a measuring cylinder and recorded as the partial milk yield after the lambs were separated from their dams twelve hours before milking (evening). This was later multiplied by 2 to give total milk obtained for that day. Milk was collected weekly for analysis. Daily milk yield was twice of the quantity of milk obtained after a 12hour separation.

Approximately 10mls fresh milk samples collected were taken to the laboratory for analysis. The milk was divided into two parts. One part was used to determine the chemical properties of the milk while the second part was used in the determination of mineral analysis. The chemical properties were determined with the aid of Lactoscan and the parameters measured includes; total solids, fat, protein, solid-non-fat, and lactose

Statistical analysis

Data obtained from the study were subjected to one way Analysis of variance (ANOVA) using SAS statistical software (SAS 2002) and where significant differences occurred, means were separated using Duncan Multiple Range Test (Duncan, 1955) with probability level of 0.05% of the same statistical package.

Experimental Model

The experimental design was Completely Randomized Design. The experimental model is as illustrated below:

$$Y_{ij} = \mu + T_i + \varepsilon_{ij}$$

Where:

Y_{ij} = observed value of the dependent variables

μ = population mean

T_i = effect due to i^{th} treatment (different treatments)

ε_{ij} = random residual value.

RESULTS AND DISCUSSION

The phytochemical composition of unfermented and fermented composite orange peels is presented in Table 1. All phytochemicals in the fermented composite were found to increase due to fermentation. This could be as a result of fermentation which help break the lignocellulose linkage and make them free form. Sun and Cheng 2002, observed that plant cell walls are known to be broken down during the process of fermentation, resulting in the release of a variety of antioxidant chemicals. The potential of fermentation to boost antioxidant activity is mostly due to the proliferation of polyphenols and flavonoids during fermentation. Fermentation produces a wide range of biological changes that alter the product's qualities, such as bioactivity and digestibility, as well as the ratio of helpful and harmful components (Zhang *et al*., 2012).

The growth performance of west African dwarf lambs and partial milk yield of wad dams fed differently processed composite orange peel diets is presented in Table 3 and figure 1. The experimental treatments had a significant effect on the pre-weaning performance of WAD lambs fed various processed composite orange peel diets in terms of weaning weight, weight gain, daily weight gain, and partial milk production. Appropriate energy levels in ewes' meals during lactation increase their body condition score, body weight, milk yield, and, subsequently, the weight gain of their lambs (Parraguez *et al.,* 2020; Santos *et al.,* 2017). Min *et al.,* (2005) concluded that, given genetic constraints, dietary factors have an effect on the yield and content of milk produced by dairy goats. Lamb birth weight has been reported to be influenced by the mother's age, size, nutrition, gestation length, offspring's sex, and litter size (Emeruwa, 2016). The pre-weaning performance features observed in this study were lower (54.84-71.58 g/d) than those reported by Chay-Canul *et al.,* (2019) for lambs gaining 150–160 g/d daily weight increase. According to Guzman *et al.*, (2020) and McGrath *et al.,* (2018), antioxidant supplementation may help reduce the deleterious effects of oxidative stress associated with growth in young ruminants, hence lowering morbidity and mortality and ultimately enhancing performance. According to Ososanya *et al*., (2007), given optimal feeding and management, at least 80% of mated ewes should lamb, with approximately 25% of ewes producing twins. Birth weight is significant for predicting the lamb's future performance since it is related to vigour at birth and helps determine the subsequent rate of increase (Emeruwa, 2016).

Effect of dietary treatment on milk composition of lactating west African dwarf dams fed experimental concentrate diets (%) is presented in Table 4. The only substantial sugar contained in milk is lactose. Lactose is a sugar that is produced exclusively by mammals and is present only in milk. Lactose is a disaccharide composed of one glucose molecule and one galactose molecule bonded together. The lactose level of milk varies significantly between experimental groups. The lactose content (3.99-4.30 %) observed in this study contradicts Adewumi and Olorunisomo (2009), who reported lactose contents of 4.07 and 4.67 percent in WAD ewes and 5.58 and 5.45 percent in Yankasa sheep during the first and second lactations, respectively. The variations in lactose concentration of milk may be related to the amount of acetate and butyric acid in the rumens of the animals, as well as the quality of feed provided to the animals. However, the finding was in line with the 4.05-4.25 percent trend reported by AL-Suwaiegh 2016 for lactating Ardi goats fed date pits. AL-Dabaib *et al*., (2009) and Min *et al*., (2005) reported similar values of 4.17-4.23 percent and 3.99-4.11 percent for Aradi goats fed discarded dates and dairy goats fed different diets, respectively. Harold (1999) showed that the maternal diet and blood glucose level have no effect on the lactose content of milk. This finding is consistent with the findings of Ahamefule *et al.*, (2003), who observed that lactose concentrations in milk remained rather constant throughout the lactation phases of cow, sheep, and goat.

The protein content of milk in this study (4.31-4.58 percent) was lower than the values of 4.77$\pm$0.45-5.83$\pm$0.29 and 4.40$\pm$0.53-5.60$\pm$0.60 reported by Khalid *et al*., (2013) for the Dubasi and Watish breeds of desert sheep fed at various molasses levels. Ochepo *et al.*, (2015); Adewumi and Olorunisomo, (2009) reported a higher value (5.37%) for WAD Sheep and 4.91 percent for Yankasa breeds; and 5.52 percent and 6.07 percent, respectively, for West African Dwarf Sheep ewes in first and second lactations. George (2010) and Alfa-Laval (1981) both reported slightly higher values of 5.98 percent, 5.2-5.17 percent, respectively. Ekeocha, (2012) also observed a slightly greater protein content of 6.12 percent in WAD ewes. The variation in some of these data could be explained by differences in feeding regimes, ration components, and forage, grain ratios that influenced milk composition and hence the ratio of acetate to propionate acid produced by feedstuffs.

Effect of lactation stages on milk composition of lactating West African Dwarf dams fed experimental concentrate diets is presented in Table 5. Total solids in sheep milk are the sum of all solid components in the milk, and hence their percentage is controlled by the percentages of the individual solid components. Milk solids content falls as lactation duration increases (Adegoke, 2006). However, the result of this investigation contradicts various previous findings regarding total solid. Alva-Laval (1981) observed that sheep milk contained a range of 17.4 to 18.9 percent. Adewumi and Olorunisomo (2009) and George (2010) revealed that the % total solids in sheep milk was 17.10–19.00 for WAD sheep and 19.20–19.90 for Yankasa ewes, respectively. Ochepo *et al.*, (2015) and Adegoke (2006) similarly reported high values for WAD sheep of 18.06 percent and 17.26$\pm$0.08-20.72$\pm$0.09, respectively. Numerous authors showed increased trend values of 11.20-12.10 percent, 11.05-17.38 percent, and 12.27$\pm$0.08-12.62$\pm$0.01 for Aradi and Red Sokoto goats (Min *et al.*, 2005; Al-Dobaib *et al.,* 2009; and Al-suwaiegh, 2016). Milk's total solid content decreases as lactation develops.

For different weeks, solid non-fat exhibits a significant difference across experimental groups and gradually declines by week three. The addition of 15% UFOP had a substantial effect on the solid non-fat content of milk, which is consistent with the findings of Alva-Laval (1981), who reported similar values of 7.8 and 9.3 percent. Adewumi and Olorunisomo (2009) reported values of 10.4 and 11.65 for the first and second lactations, respectively. Adegoke (2006), on the other hand, reported a somewhat higher figure for WAD sheep of 10.64-12.98. Several writers also documented decreasing trends in goat values; 7.85-8.14 percent, 7.20-7.32 (Al-Dobaib *et al*., 2009 and Al-Suwaiegh, 2016). Differences in dietary patterns and compositions have been observed to have an effect on milk output and composition even within the same breed of animals (Ibeawuchi, 1985).

The physicochemical properties of milk as they are altered by lactation exhibit substantial variation across lactation phases. For mid and late lactation, the fat content of milk was significantly similar. This is consistent with Phasharian *et al*., (1982), who discovered a negative correlation between the lipid content of milk and the quantity of milk produced by the animals during early lactation. This conclusion also contradicts Casoli *et al*., (1989) finding that fat content decreases as lactation develops. The density of the milk was quite high during early lactation but decreased significantly during mid- and late lactation. Milk's density can be changed by the combined effects of its various components' densities. The milk density can be influenced by a number of parameters, including the temperature history of the samples, the biological differences between micelles, the processing condition of milk, and milk with a higher solid-non-fat content (ling, 2008). Lactose levels were significantly higher during early lactation, but rapidly decreased during mid lactation, before increasing again during late lactation. Voutsinas *et al*., (1988) found no effect of lactation stage on lactose content, however Ashton *et al*., (1964) and Perrin (1958) found that lactose content increased throughout lactation. Lactose is milk's primary carbohydrate. Lactose is an important nutrient because it aids in the intestinal absorption of calcium, magnesium, and phosphorus, as well as vitamin D usage (Park *et al*., 2007). Dario *et al*., (1995) found that milk obtained from Leccese sheep had a higher lactose level at the beginning (5.32%) than at the end (4.93%) of lactation. Pavic *et al*., 2002 similarly reported a greater lactose content in milk obtained from Travnik sheep at the beginning (4.97 percent) compared to the end (4.09 percent) of lactation. Micheal (2012) found an increase in milk yield followed by a fall in milk fat and protein percentages, however yields remained constant.

Table 1: Phytochemical composition of unfermented orange peels and fermented orange peels

Parameters (g/kg)	Unfermented orange peels	Fermented orange peels	Qualitative analysis
Tannin	14.50	23.80	+
Glycosides	8.60	9.20	+
Oxalate	164.50	201.20	+++
Saponin	45.60	73.10	++
Flavonoids	69.10	84.30	++
Phytate	8.60	11.30	+

Table 2: Chemical composition and fibre fraction analysis of experimental diets

Parameters	0% OP	UFOPM	FOPM	UOP	FOP
Dry matter (%)	88.50	89.75	90.00	84.50	85.00
Crude protein (%)	13.30	13.38	13.48	6.73	9.63
Crude fibre (%)	06.68	17.09	16.27	12.33	14.80
Ash (%)	6.25	10.25	10.25	6.75	7.50
Ether extract (%)	14.50	14.75	14.75	18.50	16.50
Neutral detergent fibre	45.38	43.93	48.12	-	-
Acid detergent fibre	23.58	21.56	23.59	-	-
Acid detergent lignin	5.00	4.00	6.00	-	-

OP- orange peel, UFOPM- sundried peel meal, FOPM-fermented sundried peel meal

Table 3: Growth performance of West African Dwarf lambs and partial milk yield of WAD dams fed differently processed composite orange peel diets

Parameters	0% OP	15% UFOPM	15% FOPM	SEM
Ewes mated	8.00	8.00	8.00	0.00^{ns}
Number of ewes that lambed	8.00	8.00	8.00	0.00^{ns}
Birth weight (kg)	1.95	1.92	1.76	0.09^{ns}
Weaning weight (kg)	8.59^a	7.42^b	6.58^b	210.75*
Weight gain (kg)	6.64^a	5.53^b	4.71^b	0.25*
Daily weight gain (g/day)	76.66^a	65.78^b	56.09^b	2.99*
Partial milk yield (ml)	3012.50^a	1640.25^b	1455.25^c	0.04*

^{ab} Means in the same row having different superscripts are significantly different (P<0.05)
OP- orange peel, UFOPM- sundried peel meal, FOPM-fermented sundried peel meal

Table 4: Effect of dietary treatment on milk composition of lactating West African Dwarf dams fed experimental concentrate diets (%)

Parameters (%)	0% OP	15% UFOPM	15% FOPM	SEM
Fat	5.06^a	4.13^b	5.05^a	0.48*
Density	31.74^c	34.74^a	32.45^b	2.99*
Lactose	3.99^c	4.30^a	4.13^b	0.03*
Solid non fat	9.12^c	9.74^a	9.38^b	0.12*
Protein	4.31^c	4.58^a	4.39^b	0.02*
Temperature	31.29^a	31.26^a	31.04^b	0.22*
Freezing point	0.13^a	0.007^b	0.017^b	0.01*
Solid particle	0.66^c	0.71^a	0.69^b	0.00*

^{abc} Means in the same row having different superscripts are significantly different (P<0.05)
OP-orange peels, UFOPM- sundried peel meal, FOPM-fermented sundried peel meal

Table 5: Effect of lactation stages on milk composition of lactating West African Dwarf dams fed experimental concentrate diets

	Lactation stages			
Parameters (%)	1	2	3	SEM
Fat	4.09^b	4.84^a	5.17^a	0.69
Density	34.51^a	32.17^b	32.36^b	7.72
Lactose	4.33^a	3.91^c	4.13^b	0.04
Solid non fat	9.69^a	9.19^b	9.32^b	0.29
Protein	4.57^a	4.27^c	4.42^b	0.04
Temperature	31.31^{ab}	31.65^a	30.89^b	1.37
Freezing point	0.55^a	0.30^b	-0.49^c	0.07
Solid value	0.72^a	0.64^c	0.69^b	0.001

^{abc} Means in the same row having different superscripts are significantly different (P<0.05)
Lactation stage 1- Early lactation: Lactation stage 2- Mid lactation: Lactation stage 3- Late lactation

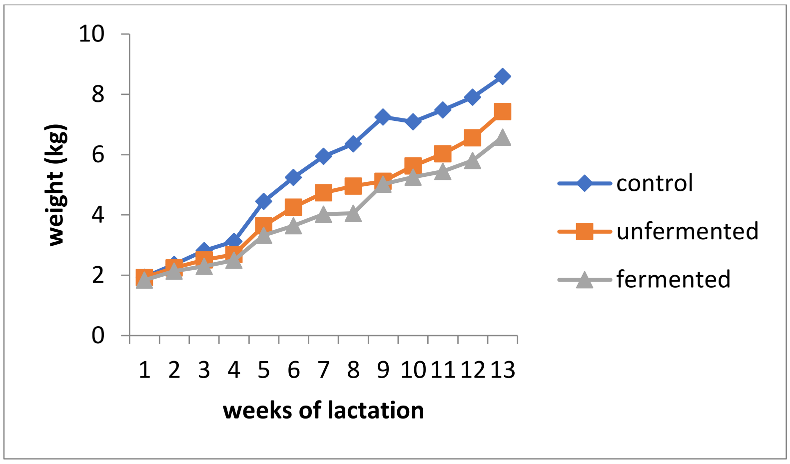

Figure 1: Performance of ewe-lamb

CONCLUSION

From the results obtained from this research it can be concluded that supplementation of 15% UFOP and 15% FOP improve milk composition as well as performance of ewe-lamb

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