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Comparison of the effects of supplementation of broiler diet with *Talinum triangulare*, *Saccharomyces cerevisiae* or a combination of both on growth performance, nutrient digestibility and carcass yield of broiler chickens

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Abstract

This study evaluated the effects of dietary supplementation with *Talinum triangulare* leaf meal (TTLM), *Saccharomyces cerevisiae* (SC), or a combination of the two (TTLM + SC) on broiler production indices. A total of 120-day old broiler chicks were used for the study. The broiler chicks were acclimatised during the one week brooding period and randomly allocated to four experimental groups (Groups A, B, C and D). Group A received basal feed without supplementation (Unsupplemented control). Group B was given feed supplemented with 60 g of TTLM per kg of feed, Group C was given feed supplemented with 0.8 g of SC per kg of feed, while Group D was given feed supplemented with a combination of 60 g of TTLM + 0.8 g of SC per kg of feed. The feeding experiment lasted for 6 weeks: 4 weeks of starter phase and 2 weeks of finisher phase. Growth performance (GP) indices, apparent nutrient digestibility (AND) and carcass yield (CY) of the broilers were evaluated. Supplementation with TTLM, SC or the TTLM + SC combination had no significant ($p > 0.05$) effect on GP indices. Supplementation with SC significantly ($p < 0.05$) enhanced AND for protein and fibre. The unsupplemented control group had significantly higher AND for fat than the supplemented groups. Combined TTLM and SC supplementation yielded significantly ($p < 0.05$) higher dressing percentage score than the SC supplemented group. Significantly ($p < 0.05$) higher yield of breast cut was recorded for TTLM supplemented group, which also had highest values for thigh and drumstick over other groups. It was concluded that supplementation with TTLM, SC or TTLM + SC combination did not significantly enhance growth performance indices in both starter and finisher phases of broiler growth, but the group supplemented with TTLM + SC combination had the overall highest dressing percentage, while the group supplemented with TTLM alone had higher breast, thigh and drumstick dress percentage. Crude protein and fibre digestibility were highest in the group supplemented with SC, while crude fat digestibility was depressed in all supplemented groups.

Keywords: Supplementation; Growth performance; Carcass yield, Broiler chickens; *Talinum triangulare; Saccharomyces cerevisiae.*

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Introduction

The use of antibiotic growth promoters (AGPs) to maintain gut health and to enhance growth performance in poultry and livestock production is gradually being phased out (Li, 2017). Manipulation of diet is therefore crucial to the maintenance and improvement of performance in animals. Apart from meeting the protein needs of the household, broiler production is the quickest way to increase the availability of high quality protein for human consumption (Chadd *et al*., 2003). One major challenge that the poultry industry faces is how to improve the efficiency of production (Paryad and Mahmoudi, 2008). The restriction of antimicrobial use in feeds has led to the search for replacement of AGPs with natural growth promoters (NGPs) in poultry and livestock nutrition. To maintain production targets and alleviate consumer-concerns on quality and safety of food-animal products, researchers and feed industry nutritionists are concentrating efforts on finding suitable alternatives to AGPs. Consequently, many nutrition studies currently are focused on use of NGPs such as phytobiotics, probiotics, prebiotics, symbiotic, organic acids, clay minerals, exogenous enzymes and nucleotides to enhance gut health and productivity of birds (Dhama *et al*., 2014).

Phytobiotics are plant-derived natural bioactive compounds with positive effects on animal growth and health (Kikusato, 2021). The term phytobiotics is often applied to essential oils (EOs), botanicals and herbal extracts (Puvaca *et al*., 2013). They are compounds of plant origin, which are incorporated into animal feeds to enhance livestock productivity through the improvement of digestibility, nutrient absorption and elimination of pathogens residents in the animal gut (Athanasiadou *et al*., 2007). Leaves, roots, flowers and whole plants are used for production of phytobiotics. Phytobiotic products may comprise the dried form of whole plants or their parts, or extracts of some valuable ingredients. Phytobiotics may be primary and secondary plant compounds. Primary phytobiotic compounds, most times, do not significantly alter the composition of main nutrients in poultry feed (Dhama *et al*., 2014). Secondary phytobiotic compounds are the main ingredients of interest in research (Grashorn, 2010). According to Nworgu *et al*. (2014) *Talinum triangulare* is the best dietary leaf meal in terms of nutritive values and performance, and also the profit it confers to poultry production. *Talinum triangulare* is rich in protein, minerals, crude fibre and bioactive contents (alkaloids, flavonoids, saponins, glycosides), which qualifies it for use as supplement. The presence of the bioactive compounds explains its use in folk medicine (ethnomedicine) for prevention and management of over 20 ailments (Tran *et al.*, 2020).

Probiotics on the other hand include non-spore formers, spore formers and yeasts that have been evaluated for their potential to improve growth rates in commercial poultry production (Shim *et al*., 2012; Bai *et al.,* 2013; Afsharmanesh and Sadaghi, 2014). In many cases the improvement in growth rate in the probiotic-treated birds was associated with increased feed intake (Landy and Kavyani, 2013; Lei *et al*., 2015) and improved feed use efficiency (Mountzouris *et al*., 2010; Shim *et al*., 2012; Zhang and Kim, 2014). *Saccharomyces cerevisiae* is a probiotic single-cell fungus that is commonly used in wine-making, baking and brewing industries since ancient times (Türker, 2014). The fungus has round to ovoid cells of about 5 - 10µm in diameter and have been referred to by several names such as Brewer’s yeast, Ale yeast, Baker’s yeast, Ragi yeast, Budding yeast and Top-fermenting yeasts (Moyad, 2008). Yeasts are known to be rich in protein, vitamins and minerals. Vitamin B1 (thiamine) is widely distributed in Brewer’s yeast in addition to vitamin B2 (riboflavin), which can be synthesized by all green plants, yeast fungi and most bacteria (Dhama *et al*., 2014).

Phytobiotics and probiotics are known NGPs (Dhama *et al*., 2014). Studies on combination therapy with some growth promoters revealed that the output in some is synergistic while others are antagonistic (Dhama *et al*., 2014). Synergy will enhance productivity above what could be obtained with individual input. This present study, which has not been documented before now, compared the effect of supplementation with *Talinum triangulare* leaf meal (TTLM), *Saccharomyces cerevisiae* (SC) or a combination of the two (TTLM + SC) on growth performance, feed digestibility and carcass quality of broiler chickens.

Materials and Methods

A total of 120 broiler chicks (day-old) hatched by Agric International Technology and Trade (Agrited™) Limited Lagos, Nigeria, were purchased through Onyinyechukwu Agro-Veterinary Consult, Nsukka, Enugu State, Nigeria, and used for the study. The birds were randomly allocated into four groups (A, B, C and D) of 30 chicks each, and housed in different poultry pens. Each group was further subdivided into 3 replicates of 10 birds each. They were housed in well ventilated deep litter pens. Brooding was done for one week following standard procedures. Heat was supplied with electric bulbs. Feeders and drinkers were cleaned daily. Feed for broilers in group A was not supplemented, and they served as the unsupplemented control. Feed for Group B broilers was supplemented with 60 g of TTLM per kg of feed, while that of Group C chicks was supplemented with 0.8 g of SC per kg of feed. The feed for Group D was supplemented with a combination of 60 g of TTLM and 0.8 g of SC per kg of feed. The feeding experiment lasted for six weeks: four weeks of starter phase and two weeks of finisher phase. The dose of 60 g of TTLM/kg of feed and 0.8 g SC per kg of feed was chosen based on unpublished pilot study on TTLM and earlier reports of the ability 0.8 g of SC to enhance growth performance in broilers (Ezema and Eze, 2009). A commercial feed (Top™, Premiere Feed Company, Sapele, Nigeria) was used throughout the experiment. Feed and water were given *ad libitum*. Regular vaccinations against Newcastle disease, Gumboro, and anticoccidial prophylactic treatment were administered following manufacturers prescription.

The study complied with the University of Nigeria standards on ethical/humane practices for the use of animals in research. The animal experimental protocol was approved by the Experimental Animal Ethics Committee of the Faculty of Veterinary Medicine, University of Nigeria, Nsukka and in compliance with the Federation of European Laboratory Animal Science Association and the European Community Council Directive of November 24, 1986 (86/609/EEC).

Parameters evaluated during the study included growth performance (GP) indices, apparent nutrient digestibility (AND) scores and carcass yield (CY). The growth performance indices investigated included daily feed intake (DFI), total feed intake (TFI), daily live body weight (DLBW), final live body weight (FLBW), daily weight gain (DWG), final weight gain (FWG), and feed conversion ratio (FCR). Daily feed intake was calculated by obtaining the difference between the weight (g) of feed offered and the remnants at end of a 24-hour period. This was divided by the number of birds in each group to obtain the average daily feed consumption per chick according to (Marwa, 2013). Total feed intake was derived as a summation of DFI. The broilers were weighed weekly. The weight of broilers at the end of the experiment was considered the final live body weight (g). The weekly weight gain (WWG) was obtained by calculating the difference between two successive weekly weights (Mohamed, 2014). From this, DWG was derived from the formula WWG/7. The final weight gain (FWG) is the difference between initial life body weight (LBW) of a chick at onset of the experiment and the final live body weight (LBW) at the end of the experiment. The weighing was done in the morning hours when their crops were empty using digital weighing balance. Feed conversion ratio (FCR) was calculated according to the method prescribed by Lambert *et al*. (1936), as follows: FCR = Feed intake (g/chick/week) **/** Body Weight Gain (g/chick/week). Mortality rate was estimated according to Vetter and Matthews (1999) equation: Mortality rate % = Number of deaths in a specified period / Total population × 100.

At the end of the 6 weeks of the feeding experiment, a representative portion of the faecal sample from each group and feed samples were collected and subjected to proximate analysis for the determination of crude protein, crude fat and crude fibre. Digestibility coefficient was computed using the formula of Perez *et al*., (1995): Apparent Nutrient Digestibility was calculated as = (NI – NE) / NI × 100, where NI represented the nutrient intake and NE expressed the nutrient excreted.

A total of 3 birds from each replicate was selected at random for carcass yield evaluation. Selected birds were stunned, and bled by severing the blood vessel and the nerve trunks at the roof of the mouth with a sticking knife. The birds were further deplumed manually and were eviscerated through a slit made between the end of the keel bone and the rectum. Dressing out percentage was calculated as a percentage of live weight. Visceral organs observed were liver, heart and gizzard. Breast, thigh and drumstick cuts were expressed as percentage proportion of dressed weight. Abdominal fat was scooped and weighed.

Data analysis: Data collected were subjected to one-way analysis of variance (ANOVA) with the SPSS version 9.0 statistical software package, and variant means were compared using the Duncan's new multiple range test (Daniel, 1995). Significance was accepted at $p < 0.05$.

Results

The results of the growth performance evaluation are presented in Tables 1 and 2 for the starter and finisher phases of the broiler growth, respectively. During the starter phase of production, broilers in the unsupplemented control group (Group A) and SC supplemented group (Group C) had significantly ($p < 0.05$) higher FLBW, DWG and FWG than the TTLM supplemented group (Group B) and the combined TTLM + SC supplemented group (Group D) (Table 1). The FCR of the Group D broilers was significantly higher ($p < 0.05$) than those of all other broiler groups. The Group B broilers had a significantly lower ($p < 0.05$) feed/water intake ratio (F/WIR) at the starter phase. However, at this starter phase, there were no significant variations ($p > 0.05$) among the broiler groups in the ILBW, TFI, DFI, TWI and DWI (Table 1).

At the finisher phase, broilers in Groups A and C had a significantly ($p < 0.05$) higher ILBW than those in Groups B and D (Table 2). The Group A broilers also had a significantly ($p < 0.05$) higher FLBW, TFI and DFI than broilers in Group D (Table 2). The FLBW of the Group C broilers was also significantly ($p < 0.05$) higher than that of Group D broilers during this finisher phase (Table 2). There was however no significant variation ($p > 0.05$) across the groups in their FWG, DWG, TWI and DWI (Table 2).

The apparent nutrient digestibility coefficients for crude protein and crude fibre was significantly ($p < 0.05$) higher in SC supplemented group (Group C) when compared to broilers in other groups, but the apparent digestibility coefficient for crude fat was significantly higher ($p < 0.05$) in the

Unsupplemented Control (Group A) broilers when compared to others (Table 3). The overall carcass dressing percentage of the Group D broilers was significantly ($p < 0.05$) higher than that of the Group C broilers (Table 4). The breast percentage of Group B broilers was significantly ($p < 0.05$) higher than those of all other groups, while the heart percentage of the Group B and C were significantly higher ($p < 0.05$) than that of the Group D broilers (Table 4). There were no significant variations ($p > 0.05$) among the broiler groups in the mean thigh, drumstick, liver, gizzard and abdominal fat percentages (Table 4).

Table 1. Growth performance (at Starter phase) of broiler chickens fed on diets supplemented with *Talinum triangulare, Saccharomyces cerevisiae* or a combination of both, compared with an unsupplemented control.

Parameters	Means with standard error in parentheses			
	Group A	Group B	Group C	Group D
Initial live body weight (ILBW) (g/bird)	42.8 (0.02)	42.8 (0.01)	42.8 (0.02)	42.8 (0.02)
Final live body weight (FLBW) (g/bird)	1172 ^{a} (11.28)	1064 ^{b} (26.04)	1175 ^{a} (31.05)	1043 ^{b} (30.23)
Final Weight gain (FWG) (g/bird)	1129 ^{a} (11.28)	1021^{b} (26.04)	1133 ^{a} (31.05)	1000 ^{b} (30.23)
Daily Weight gain (DWG) (g/bird)	37.6 ^{a} (0.37)	34.0 ^{b} (0.88)	37.8 ^{a} (1.04)	33.3 ^{b} (1.01)
Total Feed Intake (TFI) (g/bird)	2061 ^{a} (11.14)	1926 ^{a} (75.20)	2002 ^{a} (29.46)	2071 ^{a} (46.26)
Daily Feed Intake (DFI) (g/bird)	73.6 ^{a} (0.4)	68.8 ^{a} (2.68)	71.5 ^{a} (1.05)	74.0 ^{a} (1.65)
Feed conversion ratio (FCR)	1.96 ^{a} (0.03)	2.03 ^{a} (0.03)	1.89 ^{a} (0.03)	2.21 ^{b} (0.07)
Total water intake (TWI) (ml/bird)	3927 ^{a} (60.61)	4203 ^{a} (224.63)	3849 ^{a} (97.2)	4157 ^{a} (69.17)
Daily water intake (DWI) (ml/bird)	140 ^{a} (2.03)	150 ^{a} (8.02)	137 ^{a} (3.28)	149 ^{a} (2.33)
Feed/water intake ratio (F/WIR)	0.52 ^{a} (0.01)	0.46 ^{b} (0.02)	0.52 ^{a} (0.01)	0.50 ^{a} (0.01)

a, b Different superscripts in a row indicate significant differences between the groups, $p < 0.05$.

[Group A – Unsupplemented Control; Group B – 60 g *Talinum triangulare* supplement/kg of feed; Group C – 0.8 g *Saccharomyces cerevisiae* per kg of feed; Group D - 60 g *Talinum triangilare* + 0.8 g *Saccharomyces cerevisiae* combination supplement).

Table 2. Growth performance (at Finisher phase) of broiler chickens fed on diets supplemented with *Talinum triangulare, Saccharomyces cerevisiae* or a combination of both, compared with an unsupplemented control.

Parameters	Means with standard error in parenthesis			
	Group A	**Group B**	**Group C**	**Group D**
Initial live body weight (ILBW) (g/bird)	1172 ^{a} (11.28)	1064 ^{b} (26.04)	1175 ^{a} (31.05)	1043 ^{b} (30.23)
Final live body weight (FLBW) (g/bird)	1947^{a} (33.12)	1780 ^{ab} (65.91)	1929^{a} (68.20)	1732^{b} (74.76)
Final Weight gain (FWG) (g/bird)	777 ^{a} (20.28)	717 ^{a} (43.33)	750 ^{a} (81.85)	693 ^{a} (96.7)
Daily Weight gain (DWG) (g/bird)	64.7 ^{a} (1.68)	59.7 ^{a} (3.61)	62.5 ^{a} (6.82)	57.8 ^{a} (8.03)
Total Feed Intake (TFI) (g/bird)	2292 ^{a} (42.15)	2265 ^{ab} (70.06)	2265 ^{ab} (65.0)	2035 ^{b} (88.9)
Daily Feed Intake (DFI) (g/bird)	164 ^{a} (2.96)	162 ^{ab} (5.04)	162 ^{ab} (4.63)	145 ^{b} (6.33)
Feed conversion ratio (FCR)	2.85	3.03	3.00	2.95
Total water intake (TWI) (ml/bird)	5120 ^{a} (237.98)	5654^{a} (484.18)	4832^{a} (288.48)	4657^{a} (383.52)
Daily water intake (DWI) (ml/bird)	366 ^{a} (17.13)	404 ^{a} (34.6)	345 ^{a} (20.61)	333 ^{a} (27.17)
Feed/water intake ratio (F/WIR)	0.49	0.43	0.51	0.48
Mortality (%)	0	0	0	0

a, b Different superscripts in a row indicate significant differences between the groups, $p < 0.05$.

[Group A – Unsupplemented Control; Group B – 60 g *Talinum triangulare* supplement/kg of feed; Group C – 0.8 g *Saccharomyces cerevisiae* per kg of feed; Group D - 60 g *Talinum triangilare* + 0.8 g *Saccharomyces cerevisiae* combination supplement).

Table 3. Apparent nutrient digestibility (AND) coefficient of broiler chickens fed on diets supplemented with *Talinum triangulare, Saccharomyces cerevisiae* or a combination of both, compared with an unsupplemented control.

Parameters	Means ± standard			
	Group A	Group B	Group C	Group D
Crude Protein	82.87 ± 0.58 ^{b}	80.64 ± 0.58 ^{c}	85.46 ± 0.58 ^{a}	78.87 ± 0.58 ^{c}
Crude Fat	94.91 ± 0.58 ^{a}	86.32 ± 0.58 ^{b}	87.11 ± 0.58 ^{b}	75.4 ± 0.58 ^{c}
Crude Fibre	82.89 ± 0.58 ^{b}	75.61 ± 0.58 ^{c}	85.55 ± 0.58 ^{a}	75.67 ± 0.58 ^{c}

a, b Different superscripts in a row indicate significant differences between the groups, $p < 0.05$.

[Group A – Unsupplemented Control; Group B – 60 g *Talinum triangulare* supplement/kg of feed; Group C – 0.8 g *Saccharomyces cerevisiae* per kg of feed; Group D - 60 g *Talinum triangilare* + 0.8 g *Saccharomyces cerevisiae* combination supplement)

Table 4. Carcass yield of broiler chickens fed on diets supplemented with *Talinum triangulare, Saccharomyces cerevisiae* or a combination of both, compared with an unsupplemented control.

Parameters (%)	Means ± standard error			
	Group A	Group B	Group C	Group D
Dressed	81.03 ± 1.26 ^{ab}	83.83 ± 0.52 ^{ab}	80.20 ± 1.00 ^{a}	84.4 ± 1.40 ^{b}
Breast	27.57 ± 1.16 ^{a}	33.23 ± 1.58 ^{b}	28.43 ± 1.47 ^{a}	29.03 ± 0.77 ^{a}
Thigh	14.93 ± 0.67	15.70 ± 1.70	14.07 ± 0.66	15.00 ± 0.26
Drumstick	13.83 ± 0.47	15.30 ± 1.67	13.27 ± 0.41	13.30 ± 1.10
Liver	2.90 ± 0.17	2.70 ± 0.35	2.16 ± 0.37	2.60 ± 0.30
Heart	0.57 ± 0.03 ^{ab}	0.63 ± 0.03 ^{b}	0.67 ± 0.03 ^{b}	0.46 ± 0.03 ^{a}
Gizzard	2.70 ± 0.20 ^{a}	2.37 ± 0.19 ^{a}	2.83 ± 0.22 ^{a}	2.87 ± 0.17 ^{a}
Abdominal fat	1.13 ± 0.35	2.00 ± 0.62	1.63 ± 0.23	1.37 ± 0.19

a, b Different superscripts in a row indicate significant differences between the groups, $p < 0.05$.

[Group A – Unsupplemented Control; Group B – 60 g *Talinum triangulare* supplement/kg of feed; Group C – 0.8 g *Saccharomyces cerevisiae* per kg of feed; Group D - 60 g *Talinum triangilare* + 0.8 g *Saccharomyces cerevisiae* combination supplement).

Discussion and Conclusion

The growth performance indices recorded in this study showed that neither TTLM nor SC and their combination (TTLM + SC) had any significant impact on growth performance, since none of them could significantly improve the GP indices (FLW, FWG, TFI, DFI. FCR) above that of the the control. Sanda (2015) supplemented broiler diet with *Talinum triangulare* extract (TTE) in drinking water and reported similar feed intake across experimental groups; however, it was reported that FWG and FCE were significantly ($p < 0.05$) enhanced with the treatment. Nworgu *et al*. (2014) administered graded levels of TTE in drinking water of broilers and reported that high doses of TTE depressed FWG at starter phase, but enhanced WG at finisher phase. The significant depression in FLBW recorded in the TTLM supplemented groups (Groups B and D) at the starter phase may be due to the effect of supplement on feed palatability or/and on FCR. Adequate feed intake during the first week of chick's life is known to provide foundation for good growth and the basis for good overall performance. According to Olejnik et al. (2022), if early feed consumption is limited, chicks will use protein from the yolk sac for energy instead of growth. Some researchers however reported enhanced growth rate with probiotic supplementation which they associated with increased feed intake and feed efficiency (Afsharmenesh and Sadaghi, 2014; Zhang and Kim, 2014; Lei *et al*., 2015). The reports of other researchers (Fajardo *et al*., 2012; Hung *et al*., 2012; Zhao *et al*., 2013) support the current finding that GP was not enhanced with probiotic supplementation. The variations in supplementation research outcomes may be due to various factors ranging from probiotic strains used, quantity administered, route of administration (whether through feed or water) and breed/strain of birds etc.

Total nutrient digestibility and protein efficiency was enhanced with SC and fat digestibility was optimum with the unsupplemented group. The poor digestibility score of the group treated with TTLM and its combination with SC is in contrast with the reports of Nworgu *et al*. (2014) which stated that *Talinum triangulare* extract (TTE) in drinking water of broilers enhanced nutrient digestibility and protein efficiency. The form and route of administration of the supplement may also account for the differences; administration of TTE through water had been reported to enhance efficiency of TTLM better than inclusion in feed (Aronu *et al*., 2020). The reports of Li *et al*., (2008) on enhanced apparent digestibility of dry matter, energy, crude protein, calcium, phosphorus and amino acids in broilers fed maize-soybean-based diet supplemented with commercial probiotic containing yeast and other microbes concurs with the results obtained in this present study. The interaction of SC with other components of the feed may probably have determined digestibility outcome.

The trait of economic importance in chicken is the dressing percentage, and the breast, thigh and drumstick are the primal cuts of high economic value that constitute on the average 34%, 23% and 21%, respectively, of the total edible part of dressed chicken slaughtered at 3 kg live weight (Omojola *et al*., 2004). Supplementation with TTLM yielded the highest values for each of the three carcass yield indices. Supplementation with SC however had no significant effect on carcass yield. The report of Mohamed *et al*. (2015) is in agreement with this finding. However, Jin *et al*. (1998), Kannan *et al*. (2005) and Zhang *et al*. (2006) all reported that the inclusion of graded levels of SC in broiler chicks' rations significantly affected all carcass characteristics measured (dressing percentage, breast, leg, liver, heart, gizzard and abdominal fat percentage).

The significantly higher dressing percentage recorded for the Group D broilers suggests synergism between TTLM and SC combined in the supplement added to the Group D diet. Ribeiro (2019) reported that the combination of SC and polyphenolic compounds of plant origin increased the absorption of the later by the body compared to direct ingestion. It has also been demonstrated that the use of SC enriched with polyphenolic compounds promoted an increase in the bio-accessibility of these bioactive compounds (Jilani *et al*., 2015; 2016).

It was concluded that supplementation with TTLM, SC or the combination of both (TTLM + SC) at the doses used in this study did not significantly enhance growth performance indices in both starter and finisher phases of broiler growth, but the group supplemented with combination of TTLM + SC had the overall highest dressing percentage, while the group supplemented 60 g of TTLM/kg feed had higher breast, thigh and drumstick dress percentage. Crude protein and fibre digestibility were highest in the group supplemented with SC, while crude fat digestibility was depressed in all supplemented groups.

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Conflict of Interest

Authors of this manuscript hereby certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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