Enhancing Pork Quality: Impact of *Jathropha tanjorensis* and *Psidium guajava* Leaf Meals on Carcass Traits, Physicochemical Properties and Sensory Appeal

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ABSTRACT

Jathropha tanjorensis popularly known as hospital is too far and *Psidium guajava* (guava leaf) are plants of interest containing promising phyto-additives with the potentials to improve pork quality and carcass traits. This study evaluated the effects of *Jathropha tangorensis* and *Psidium guajava* leaf meals on pork quality in terms of sensory attributes, chemical composition, and carcass traits. In a completely randomized design, twenty-four grower pigs (21.81±2.15 kg) were randomly assigned to three dietary treatments with eight (8) pigs per treatment and further replicated twice (4 pigs per replicate). The dietary regimens were as follows: the basal diet group, which served as the control, the *Jathropha tanjorensis* Leaf Meal (JTLM) and Psidium guajava Leaf Meal (PGLM) groups. The additives were included at 3% of body weight, with two replicates of four pigs per regimen. Results showed JTLM and PGLM significantly ($P < 0.05$) improved carcass traits ($P < 0.05$) compared to control. Pre-slaughter weight, dressed weight, shank, belly, breast, and thick rib chop were higher ($P < 0.05$) in JTLM and PGLM groups. Test ingredients also elicited increase in organ weights. Abdominal fat differed significantly ($P < 0.05$), with the control group showing the highest value (10.00g) compared to JTLM (0.00g) and PGLM (0.00g). Pork physicochemical properties improved significantly ($P < 0.05$) in the JTLM and PGLM groups. Cooking loss, cooking yield, and water holding capacity showed significant ($P< 0.001$) differences. Taste panelists preferred pork from JTLM and PGLM groups for flavour, juiciness, and tenderness. Conclusively, JTLM and PGLM have good application values as potential feed additives for growing pigs. Dietary supplementation with *Jathropha tanjorensis* and *Psidium guajava* at 3% of body weight can improve pork quality including carcass traits, physicochemical properties, and sensory appeal. Higher inclusion levels of the leaf meals are encouraged in future studies.

Keywords: Pork quality, Meat quality, Physicochemical properties, *Psidium guajava*

INTRODUCTION

The global demand for high-quality pork remains strong because of its significant role as a primary protein source in the human diet (1). However, modern pork production faces increasing scrutiny regarding its sustainability, environmental impact, and alignment with consumer preferences for healthier, more ethically and naturally produced meat (2, 3). These challenges have prompted the exploration of alternative feed ingredients that can improve pork quality, while supporting environmentally friendly and sustainable practices (4). One promising avenue is the use of plant-based feed additives from underutilised plants, such as *Jatropha tanjorensis* and *Psidium guajava* leaf meal, which are known for their bioactive properties and nutritional benefits (5, 6).

Jatropha tanjorensis popularly known as hospital is too far and *Psidium guajava* (apple guava), which are rich in phytochemicals, such as flavonoids, phenolic acids, tannins, and other antioxidants, have demonstrated potential for improving livestock growth performance and immune responses (7). Although their functional attributes are well documented, their specific effects on pork quality, particularly sensory appeal, physicochemical properties, and carcass traits, have received limited attention. Addressing this gap is crucial for optimising pork production in a sustainable and consumer-focused manner. *Psidium guajava* is particularly abundant in polyphenols, including tannins (2-4 %), which exhibit strong antioxidant properties and may contribute to improved meat quality (5,8). Additionally, *Psidium guajava* contains vitamin C and carotenoids that are also noted for their antioxidant action (9). Similarly, *Jatropha tanjorensis* is a valuable source of bioactive compounds such as tannins, alkaloids, phenols, flavonoids, and saponins (6). The antioxidative potential of polyphenols has been widely studied (10, 11), with evidence suggesting their role in enhancing muscle polyphenol deposition, delaying lipid oxidation, and improving colour, flavour, and overall meat quality. For instance, dietary supplementation with quebracho (*Schinopsis lorentzii*) extract, rich in tannins, increased the total phenolic content of *longissimus dorsi* muscle in lambs (12). Comparable findings were reported in pigs fed *Vernonia amygdalina* and *Jatropha tanjorensis* leaf meal, where significant improvements in growth performance, carcass traits, and meat quality attributes were observed (12, 6). Furthermore, polyphenol supplementation in meat products has been shown to extend shelf life by mitigating lipid oxidation and enhancing colour and flavour stability (14).

Physicochemical properties such as pH, water-holding capacity, and cooking yield are critical determinants of pork quality and consumer acceptance. Both *Jatropha tanjorensis* and *Psidium guajava* leaf meals have been shown to contain high levels of antioxidants, which can enhance meat quality by mitigating oxidative stress during production and storage (15). Additionally, the sensory appeal of pork, which is characterised by attributes such as flavour, tenderness, and juiciness, is a key driver of consumer preference. Despite the known nutritional and bioactive benefits of these plant-based meals, their direct influence on the sensory attributes of pork has remained under explored.

Carcass traits, including fat distribution, muscle development, and overall yield, are important indicators of pork quality. Previous studies have suggested that dietary supplementation with bioactive plant-based feed additives can influence the balance between fat and muscle deposition, potentially improving carcass composition (7, 16). However, a detailed examination of how *Jatropha tanjorensis* and *Psidium guajava* leaf meals affect these traits has not been previously undertaken, leaving a significant knowledge gap. Taking into consideration the many benefits these phyto-additives offer, this study therefore sought to investigate the effects of *Jatropha tanjorensis* and *Psidium guajava* leaf meals on the sensory appeal, physicochemical properties, and carcass traits of pork.

MATERIALS AND METHODS

Study Site, Sourcing and Processing of Test Materials

This experiment was conducted at the Piggery Unit of the Teaching and Research Farm of Akwa Ibom State University, Obio Akpa, Nigeria. *Jathropha tanjorensis* and *Psidium guajava* leaves were obtained from Abak town in Akwa Ibom State, Nigeria. The leaves were harvested, thoroughly cleaned under running water, and subsequently chopped with a kitchen knife before being air-dried for two days to mitigate the effect of any antinutritional factors. Upon drying and milling, two leaf meals were obtained and designated *Jathropha tanjorensis* leaf meal (JTLM) and *Psidium guajava* leaf meal (PGLM).

Experimental Diets and Design

The experimental diets consisted of the control group (basal diet), the JTLM group (basal diet + JTLM), and the PGLM group (basal diet + PGLM). Both leaf meals were incorporated into the daily rations at 3% of the experimental animals' body weights. Feed and water were provided *ad libitum* twice daily (08:00 hours and 16:00 hours). The feeding trial lasted 56 days. The experimental rations were formulated to meet the nutritional needs of the animals in line with the recommendations of NRC (41).

Experimental Animals

A total of twenty-four (24) young boars (Landrace × Large White) with an average initial weight of 21.81±2.15 kg was acquired from the pig farm of the Department of Animal Science, Akwa Ibom State University, Obio Akpa campus, and used for the experiment.

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Experimental Design

The pigs were randomly distributed in a completely randomized design, with one control treatment and two other diets, all comprising of three treatments. Each treatment group contained eight pigs and was replicated twice with four pigs per replicate.

Carcass Analysis

On day 56 (8weeks) of the feeding trial, carcass traits were determined in two pigs per replicate (12 per treatment) after withdrawing feed 12h prior with the aim of clearing the gut content and reducing the contamination rate. The pigs were slaughtered manually via exsanguination, bleeding, and expulsion of the gut content. The dressed weight obtained was used to calculate the dressing percentage as the ratio of dressed weight to live weight multiplied by 100. Each organ (heart, liver, kidney, and lungs) and abdominal fat were removed and weighed, and weights were expressed as a percentage of the live weight. The carcass was fabricated into different primal cuts which include the shoulder, loin, belly, leg and weighed using digital scale (Ohaus Explorer EX324, Ohaus corporation, New Jersy, USA) accordingly. Fresh meat samples obtained from the right thigh were used to determine the meat-to-bone ratio.

Sensory Evaluation

Fresh pork samples (200g) obtained from the left thigh muscle were cooked before being subjected to sensory evaluation as described by Jezek *et al.* (17) using a 9-point hedonic scale (1 = extremely dislike to 9 = like extremely). A 24-member trained taste panel was set up to perform the sensory evaluation. The meat was rated for colour, flavour, tenderness, juiciness, and overall acceptability.

Determination of cooking loss

This was determined according to the procedure outlined by Xu *et al* (18). The samples were individually wrapped in heat-resistant polythene bags and immersed in boiling water at 75°C for 20 min. After cooking, the meat samples were reweighed, and cooking loss was calculated as the percentage change in weight after cooking.

Determination of thermal shortening

The length of the meat was measured, and the meat was placed in a heat-resistant polythene bag immersed in boiling water and allowed to cook for 20 min at 80°C. The length of each sample was measured after cooking. The percentage change in the length of meat was taken as thermal loss (19).

Determination of water holding capacity

This was determined using the press method (20, 21). A sample of 1 g of meat was placed between two 9 cm Whitman No. 1 filter papers and pressed between plexiglasses using a vice for one minute. The meat sample was removed and oven-dried at 105^{0} C for 24 hours to determine the moisture content. The amount of water released from the meat samples was measured indirectly by measuring the area of filter paper wetted relative to the area of the pressed meat samples. The water-holding capacity was calculated as follows:

$$WHC = \frac{100 - (AW - AM) \times 9.4}{Wm \times Mc}$$

Where, Aw = Area of meat samples (cm); Wm = weight of meat samples (g)

Mc = Moisture content of meat samples (%): 9.47 = a constant factor

STATISTICAL ANALYSIS

Data obtained were subjected to a one-way analysis of variance using GraphPad Prism (version 8.0.2, 268), while the means with significance ($p<0.05$) were separated using Tukey’s test of the same package.

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RESULTS AND DISCUSSION

The result of vitamin and phytochemical analysis of *Jathropha tanjorensis* and *Psidium guajava* leaf meals is presented in table 1.

Table 1: Phytoconstituents and vitamins of *Jathropha* & *guajava* leaf meals

Parameter (mg/100g)	JTLM	PGLM
Saponins	220	200
Tannins	400	1000
Alkaloids	300	210
Flavonoids	900	1200
Terpenoids	180	150
Phenols	1200	1800
Ascorbic acid	22.47	215
Vitamin A	5.94	3.15
Vitamin E	3.77	1.1

Jathropha tanjorensis =JTLM; Psidium *guajava* =PGLM.

As presented in table 1, Saponin was slightly higher in JTLM than PGLM. In contrast, tannin, flavonoids and phenols were considerably higher in PGLM than JTLM. Vitamin A was slightly higher in JTLM than PLGM. However, vitamin C was significantly higher in PLGM than JTLM while vitamin E was considerably higher in JTLM compared to PLGM. This result is comparable with earlier reports by (42,43). These are majorly antioxidants which could have reduced oxidative degradation in pork meat, increased carcass yield and quality in terms of fat reduction as well as enhanced sensory properties of pork.

Table 2: Carcass traits of pigs fed *Jathropha tanjorensis* and *Psidium guajava* leaf meals

Parameters	**Control (CTL)**	**JTLM**	**PGLM**	**SEM**	**P-values**
Pre-slaughter weight (kg)	37.56^{b}	42.10^{a}	39.00^{b}	0.73	0.004
Dressed weight (kg)	20.00^{b}	25.27^{a}	22.00^{b}	0.82	0.002
Dressing (%)	53.24	60.00	56.41	1.95	0.419
Head (kg)	3.00	3.10	3.05	0.17	0.978
Shank (kg)	0.30^{b}	0.70^{a}	0.60^{a}	0.07	0.007
Belly (kg)	1.40^{b}	1.74^{a}	1.64^{a}	0.05	0.001
Breast (kg)	1.30^{b}	1.90^{a}	1.50^{b}	0.09	0.000
Thick rib chop (kg)	1.20^{c}	1.94^{a}	1.62^{b}	0.11	0.000
Rib chop (kg)	1.10^{b}	1.40^{a}	1.20^{ab}	0.05	0.027
Loin (kg)	0.86^{c}	1.45^{a}	1.11^{b}	0.09	0.000
Chump chop (kg)	0.90^{b}	1.34^{a}	1.20^{a}	0.07	0.005
Leg fillet end (kg)	1.00	1.30	1.10	0.17	0.819
Leg shank end (kg)	1.20	2.00	1.40	0.21	0.291
Kidney (% LW)	0.35^{c}	0.56^{b}	0.86^{a}	0.08	0.000
Lungs (% L.W)	1.30^{b}	1.80^{a}	1.70^{a}	0.08	0.002
Liver (% L.W)	1.25^{c}	1.45^{b}	1.75^{a}	0.07	0.000
Spleen (% L.W)	0.37^{b}	0.84^{a}	0.54^{b}	0.07	0.003
Heart (% L.W)	0.41^{b}	0.61^{b}	0.91^{a}	0.08	0.000
Abdominal fat (g)	10.00^{a}	0.00^{b}	0.00^{b}	1.67	0.000
Meat to bone ratio	2.00	3.57	2.67	0.37	0.235

^{abc} means on the same row with different superscripts are significantly different ($p<0.05$) JTLM = *Jathropha tanjorensis* leaf meal; PGLM = *Psidium guajava* leaf meal. LW = Live weight.

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Carcass traits of the Pigs

The carcass traits of pigs fed *Jathropha tanjorensis* and *Psidium guajava* leaf meal are presented in Table 2. Feeding regimens indicated significant differences (p<0.05) in the pre-slaughter weight, dressed weight, and cut parts including shank, belly, breast, thick rib chop loin, and chump chop. Similarly, all internal organs and abdominal fat were significantly (p<0.05) influenced by the feeding regimen. Pigs fed diets containing JTLM recorded higher values, followed by those in the PGLM group, whereas the CTL group recorded the lowest values across all parameters. Apart from carcass yield being influenced by pre-slaughter weights, which are mostly true impacts of diets (22), *Jathropha tanjorensis* and *Psidium guajava* are rich in antioxidants (table 1) known to reduce oxidative stress (23), which may result in better nutrient utilization and improved carcass traits obtained in the JTLM and PGLM groups. However, the increase observed in the organ weights could be related to the higher fibre content in the feed served to the pigs in the JTLM and PGLM groups, which engaged the animal's gastrointestinal tract and other organs to work more to digest and utilise the ingested fibre. The results obtained for abdominal fat showed a significant reduction in the JTLM and PGLM groups. This implies that the test ingredients which contained antioxidants such as flavonoids and polyphenols may have increased fat oxidation, regulation of blood sugar levels and reduced fat storage. Our observations are similar to earlier reports on pigs fed phyto-additives (24, 13). Nobre *et al.* (25), in a previous study on lambs reported that feeding 20% of guava leaves did not have any detrimental effect on the carcass.

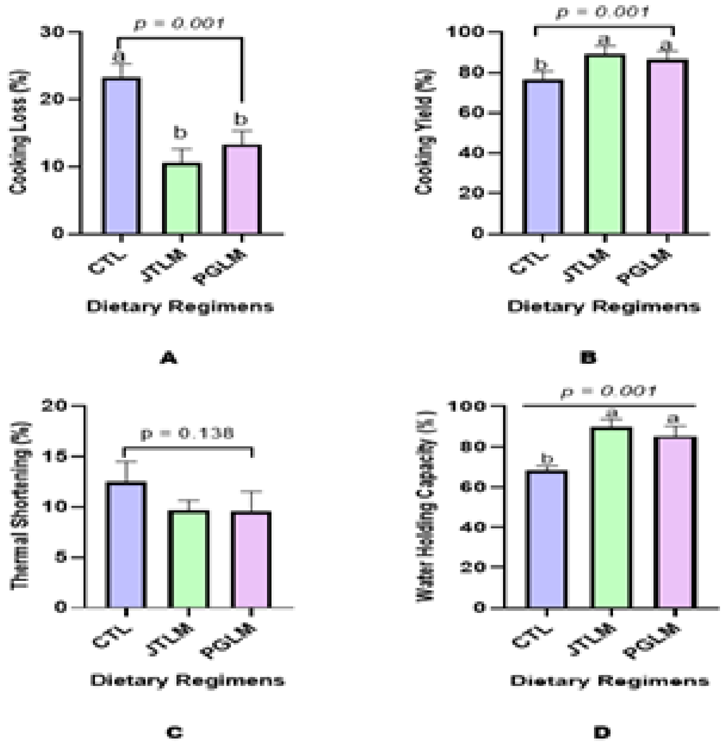

Figure 1 (A, B, C, D): Physicochemical properties of pork from pigs fed diets containing *Jathropha tanjorensis* and *Psidium guajava* leaf meal. Different letters on top of the data bars indicate significant differences (p<0.05) between the mean values. JTLM = *Jathropha tanjorensis* leaf meal; PGLM = *Psidium guajava* leaf meal.

Physicochemical Properties of the Pork

The physicochemical properties of pork, including pH, water-holding capacity (WHC), and cooking yield (CY), play a crucial role in determining the overall quality and consumer acceptance of pork products (26). These properties are interconnected and influence various aspects of meat characteristics. Figure 1 presents the physicochemical properties (cooking loss, cooking yield, thermal shortening, and water-holding capacity) of pork from pigs fed diets containing *Jathropha tanjorensis* and *Psidium guajava* leaf meal.

1. Cooking Loss of the pork

The use of Phyto-additives in animal feed has shown positive effects on meat quality parameters, including cooking loss. As presented in Figure 1A, feeding regimens significantly ($p<0.05$) reduced cooking loss (CL) in the JTLM and PGLM groups compared with the CTL (control) group. This reduction may be attributed to the presence of antioxidants in the plant leaves (table 1). Studies have shown that antioxidants not only reduce oxidative stress and protein degradation during processing but also preserve muscle proteins (myofibrils), thus improving the ability of meat to retain moisture (lower cooking loss) (27-29). Ayanwale and Aye (30) reported that lower cooking loss is considered an advantage in meat production because it leads to improved tenderness, juiciness, and more favourable meat quality compared to meat with high cooking loss. Generally, fluid loss from meat leads to loss of water-soluble vitamins and nutrients, which can affect juiciness and flavour. According to a study on lambs, dietary phyto-additive supplementation significantly decreased cooking loss compared to the control group (31).

2. Cooking Yield of the pork

Cooking yield is inversely proportional to cooking loss and important in determining meat's final product texture and economic value (32, 26). Cooking yield is influenced by factors such as the cooking method, temperature, and duration. Higher cooking yields generally result in improved texture, juiciness, and overall meat quality, and are often preferred by consumers. As indicated in Figure 1B, pork in the JTLM and PGLM groups showed significantly ($p<0.05$) higher CY values than the CTL group. The low cooking loss recorded in these groups, achieved by the application of a low cooking time and temperature, may have been a possible reason for this observation. This is in line with the report by Latoch (32) that marinating meat in fermented dairy products and using sous-vide cooking at lower temperatures can increase tenderness and improve cooking yield (40). The protein stabilization ability of some of the antinutrients in the tested ingredient, together with their antioxidant properties (30), may also have contributed to the increased cooking yield. The addition of plant-based ingredients significantly decreased cooking loss and increased moisture retention and yield of beef patties, leading to improved texture (28).

3. Thermal Shortening of the pork

Thermal shortening, as illustrated in Figure 1C, did not differ significantly ($p>0.05$) across feeding regimens. However, lower values were observed in the JTLM and PGLM groups, while the CTL group exhibited the highest value. The high thermal shortening in the CTL group may be attributed to greater moisture loss, leading to muscle shrinkage. Phyto-additives contain antinutritional factors with water-binding properties, which may mitigate moisture loss during heating (33). As meat proteins denature and contract under thermal processing, water is expelled from the muscle structure, influencing moisture retention and overall meat quality. Comparative studies have evaluated weight loss, moisture content, and water-holding capacity between sous-vide and conventionally cooked meats, demonstrating that sous-vide cooking yields lower cooking losses and higher water-holding capacity, indicative of reduced thermal shortening (34,19) . Additionally, hot-boning combined with sous-vide cooking has been reported to minimise muscle shortening compared to wet-aged meats subjected to conventional cooking methods (19). These reports further stress the role of pre-cooking muscle state in determining thermal shortening outcomes. Our findings emphasize the influence of these dietary phyto-additives and cooking techniques on muscle integrity and moisture dynamics, which are critical determinants of meat quality.

4. Water-Holding Capacity of the pork

Meat's juiciness during storage and cooking is crucial for consumer's acceptability. This is achievable by maintaining a good water-holding capacity of meat. The feeding regimens in this study showed significant ($p<0.05$) differences in WHC (Figure 1D). Higher WHC values were observed in the JTLM and PGLM groups than in the CTL (control) group. The low cooking loss values recorded for the JTLM and PGLM groups may have contributed to the observed high WHC values. Additionally, the bioavailability and efficacy of an antinutritional compound (tannins) in the tested materials may have helped stabilize the protein structures of pork, potentially leading to improved water-holding capacity (35). Water plays a crucial role as a plasticizer and maintains the flexibility of muscle proteins. However, when meat is cooked, protein denaturation occurs, causing water to expel from the myofibrillar lattice structure. As a result, muscle fibre volume decreases, leading to moisture loss, particularly at higher cooking temperatures (36). Our findings contrast with those of Verma *et al*. (37), who reported that dietary phyto-additive supplementation in sheep nuggets reduced water-holding capacity due to lower emulsion stability, cooking yield, and moisture content, indicating a negative impact on meat quality. Conversely, Joo *et al*. (38) observed that pigs fed conjugated linoleic acid (CLA)-supplemented diets exhibited lower purge loss, suggesting improved WHC through increased intramuscular fat deposition.

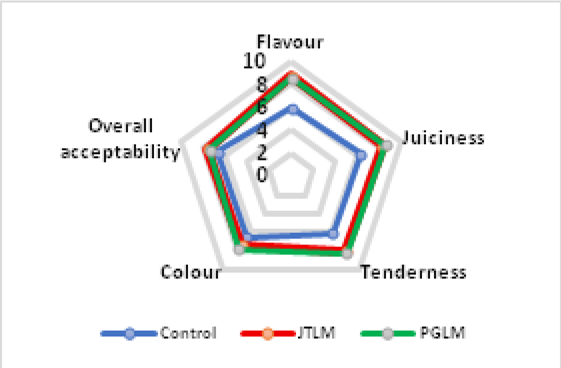

Figure 2: Sensory appeal of pork from pigs fed diets containing *Jathropha tanjorensis* and *Psidium guajava* leaf meals

Sensory evaluation of the pork

The sensory appeal of pork from pigs fed diets containing *Jathropha tanjorensis* and *Psidium guajava* leaf meals is presented in Figure 2. The results indicated significant differences ($p<0.05$) in flavour, juiciness, and tenderness between the treatments. Colour and overall acceptability, however, indicated no significant differences ($p>0.05$). Pork in the PGLM and JTLM groups were preferred by the taste panelists compared to those in the CTL group. *Psidium guajava* and *Jathropha tanjorensis* leaves contain phenolic and volatile compounds, such as limonene, flavonoids and tannins which can contribute to the formation of flavour precursors in meat (39). Our results agree with those of (25), who fed lambs supplemental guava waste and reported no negative change in sensory attributes. Tannins and vitamin C in *Jathropha tanjorensis* and *Psidium guajava*, respectively, might have stabilized the protein structure of pork, leading to improved water-holding capacity, tenderness, and juiciness. Our findings align with those of Tran *et al.* (27), Ekpo and Okon (6), and Sahal *et al*. (29), who reported that Jatropha and guava leaves positively influence meat quality. The phytogenic compounds in these plants have been shown to enhance sensory properties and extend the shelf life of pork, thereby improving consumer acceptability.

CONCLUSION

This study revealed that the inclusion of *Jathropha tanjorensis and Psidium guajava* leaf meals in pig diets improved meat quality by reducing fat deposition while increasing dressing percentage and primal cuts. The phyto-additives reduced thermal and cooking losses while improving sensory properties such as juiciness, juiciness and tenderness. Based on the results obtained from this study, both *Jathropha tanjorensis and Psidium guajava* leaves are recommended for inclusion in pig diets at 3% of body weight to obtain improved accretion of lean meat in pig carcasses, higher carcass yield and better sensory appeal from the resulting meat.

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Conflict of Interest

This study was conducted with no conflicts of interest.

Ethical Approval

The study was approved by the Akwa Ibom State University Ethical Review Board, and all procedures involving human participants adhered to the board's ethical guidelines and standards.

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