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# Growth response, carcass analysis and sensory evaluation of meat from broiler chicken served acidified water

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## Abstract

*Due to the emergence of drugs resistance microorganisms, side effects of antimicrobials and harmful residual toxicity effects of drugs observed in food chain, there is an increasing trend towards the use of alternatives for the general health maintenance. This study was carried out using 135 day old arbor acre chicks to evaluate the growth response, carcass and sensory evaluation of meat obtained from broiler chickens served two different organic acids. The chicks after brooded for a period of seven days were randomly distributed into five treatments group of 27 chicks per treatment replicated thrice with 9 birds per replicate in a completely randomized design (CRD). Treatment 1 served as the control without oral inclusion of organic acid, $T_2$ had 2% citric acid, $T_3$ had 4% citric acid, $T_4$had 2% acetic acid and $T_5$ had 4% acetic acid respectively while all administration was done two weeks at starter phase and two weeks at finisher phase. parameter measured includes feed intake, weight gain, feed conversion ratio and mortality percentage while two birds per replicate making 6 per treatment were randomly selected, slaughtered and dissected for carcass, meat quality and sensory evaluation respectively. Result obtained showed no significant ($P > 0.05$) difference in all growth parameters measured. Significant ($P< 0.05$) differences were obtained on the mean value recorded for drumstick, wing, neck, head and gizzard among all carcass parameters measured. Higher ($P< 0.05$) values for drumstick was obtained on $T_2$ (11.17) followed by $T_1$ and $T_4$(10.65 and 10.67) while the least values was recorded for $T_3$ and $T_5$ (9.54 and 10.10). The same trend was observed for gizzard. Significant ($P< 0.05$) differences were obtained in cooking loss recorded on breast muscle and on chilling loss recorded on thigh muscle and drumstick across the treatment for all parameters measured for meat quality attributes. Sensory evaluation results revealed similarities in the values obtained for colour, appearance, flavor, texture, taste and overall acceptance. Conclusively, the inclusion of citric and acetic acid orally for broilers had no detrimental effect on growth performance but enhance the quality of the carcass.*

**Keywords:** Citric acid, acetic acid, organoleptic properties, broiler muscle, primal cuts

## Résumé

*En raison de l'émergence de micro-organismes résistants aux médicaments, des effets secondaires des antimicrobiens et des effets toxiques résiduels nocifs des médicaments observés dans la chaîne alimentaire, il existe une tendance croissante à l'utilisation d'alternatives pour le maintien de la santé générale. Cette étude a été réalisée en utilisant des poussins âgés de 135 jours pour évaluer la réponse de croissance, la carcasse et l'évaluation sensorielle de la viande obtenue à partir de poulets à griller servis avec deux acides organiques différents. Les poussins après avoir été couvés pendant une période de sept jours ont été répartis au hasard dans cinq groupes de traitements de 27 poussins par traitement répétés trois fois avec 9 oiseaux par répétition dans une conception complètement*

*randomisée (CCR). Le traitement 1 a servi de contrôle sans inclusion orale d'acide organique, $T_2$ avait 2 % d'acide citrique, $T_3$ avait 4 % d'acide citrique, $T_4$ avait 2 % d'acide acétique et $T_5$ avait 4 % d'acide acétique, respectivement, tandis que toute l'administration était effectuée deux semaines à la phase de démarrage et deux semaines en phase finisher. Le paramètre mesuré comprend l'apport alimentaire, le gain de poids, l'indice de conversion alimentaire et le pourcentage de mortalité, tandis que deux oiseaux par répétition, soit 6 par traitement, ont été sélectionnés au hasard, abattus et disséqués pour la carcasse, la qualité de la viande et l'évaluation sensorielle, respectivement. Le résultat obtenu n'a montré aucune différence significative (P > 0,05) dans tous les paramètres de croissance mesurés. Des différences significatives (P < 0,05) ont été obtenues sur la valeur moyenne enregistrée pour le pilon, l'aile, le cou, la tête et le gésier parmi tous les paramètres de carcasse mesurés. Les valeurs les plus élevées (P < 0,05) pour le pilon ont été obtenues sur T2 (11,17) suivi de T1 et T4 (10,65 et 10,67) tandis que les valeurs les plus faibles ont été enregistrées pour T3 et T5 (9,54 et 10,10). La même tendance a été observée pour le gésier. Des différences significatives (P < 0,05) ont été obtenues dans la perte à la cuisson enregistrée sur le muscle de la poitrine et dans la perte au froid enregistrée sur le muscle de la cuisse et le pilon tout au long du traitement pour tous les paramètres mesurés pour les attributs de qualité de la viande. Les résultats de l'évaluation sensorielle ont révélé des similitudes dans les valeurs obtenues pour la couleur, l'apparence, la saveur, la texture, le goût et l'acceptation globale. En conclusion, l'inclusion d'acide citrique et acétique par voie orale pour les poulets de chair n'a eu aucun effet néfaste sur les performances de croissance mais a amélioré la qualité de la carcasse.*

**Mots-clés** : Acide citrique, acide acétique, propriétés organoleptiques, muscle de poulet de chair, coupes primaires

## Introduction

Approvals for the use of non-therapeutic antibiotics in animal feed are fast disappearing worldwide. The primary effect of antibiotics is antimicrobial as all of the digestibility and performance effects can be explained by their impact on the gastrointestinal microflora. Among the replacements for antibiotics are organic acids which composed of individual acids and blends of several acids**.**Organic acids (citric acid, lactic acid, propionic acid etc.) have mainly been used in order to sanitize feed to prevent issues such as salmonella infections in animals (Thompson and Hinton, 1997). Their effect in animal diets may also suppress pathogenic growth and improve digestion, absorption, mucosal immunity and topical effects on the intestinal brush border (Mroz, 2005). Like antibiotics, short-chain organic acids also have a specific antimicrobial activity (Wang *et al.,* 2009). Organic acids have been used for decades in commercial compound feeds mostly for feed preservation, in which formic and propionic acids are particularly effective (Luckstadt, 2014). As a group of chemicals, organic acids are considered to be any organic carboxylic acid, including fatty acids and amino acids, of the general structure R-COOH. Salts of some of these acids have also been shown to have performance benefits in poultry production. A wide range of organic acids with variable physical and chemical properties exists, of which many are used in drinking water as supplement or feed additives (acidifiers). The use of organic acids has been reported to protect the young chicks by competitive exclusion (Mansoub *et al*., 2011), enhancement of nutrient utilization, growth and feed conversion efficiency (Luckstadt and Mellow, 2011). Citric acid (CA) is the most common organic acid used in poultry diets. It acts as a growth promoter through

acidifying the gastrointestinal (GI) content and is considered as a favoured determinant in effective nutrient digestion. In addition, CA also improves the solubility of the feed ingredients, digestion and absorption of nutrients by modifying intestinal pH (Islam *et al*., 2008). Acetic acid is an organic acid which is used primarily to control mold and reduce bacterial growth in feed, but it can also inhibit the growth of micro-organisms in the gastrointestinal tract, modify pH levels and improve feed utilization. Hence, this study was conducted to evaluate the growth response, carcass analysis and sensory evaluation of the primal cuts of broiler chicken served oral administration of acetic and citric acid.

## Materials and methods

### *Experimental birds and management*

The experiment was carried out at the Poultry Unit, Teaching and Research section of the Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan, South West, Nigeria. A total of One hundred and thirty- five (135), 7- day old chicks having initial average weight of 170g ± 5 were randomly allotted into five dietary treatments of twenty- seven chicks per treatment. Each treatment was in triplicate of nine chicks per replicate in a completely randomized design. Birds were raised on partitioned deep litter pen and the experiment lasted for 7 weeks. Acetic and Citric acid were administered orally for two weeks at both starter and finisher phases in the following order: $T_1$ served as the control (no oral inclusion), $T_2$ were served 2% citric acid, $T_3$ were served 4% citric acid, $T_4$ were served 2% acetic acid and $T_5$ were served 4% acetic acid respectively, all administration was done two weeks at the starter phase and two weeks at the finisher phase. Feed and water were supplied *ad libitum*. Routine vaccination and management practices were strictly adhere to while only birds on control treatment were medicated.

### *Growth response*

Data on feed intake, weekly weight gain, average daily feed consumed and body gain, feed-to-gain ratio were obtained to evaluate the growth response of the experimental birds.

### *Carcass traits*

At the end of the feeding trial, two birds per replicate were purposively selected, starved overnight, weighed to obtain the live weight and severed through the jugular vein for carcass analysis. Internal organ like heart, liver, kidney, lungs, abdominal fat and gizzard were weighed and recorded as well as all other parts and expressed as percentage of dressed weight as described by (Okuedo*et al*., 2005).

### *Meat quality attributes*

Primal cuts (Breast, thigh and drumstick) from each carcass were weighed and used to determine the quality attributes of the meat sample according to the method described by ( Omojola*et al.,* 2007).

### *Sensory evaluation*

The sensory properties of the primal cuts from each carcass were evaluated using a nine point hedonic scale with ten-member trained taste panel according to the procedure described by Egbunike and Okubanjo (1999); Omojola (2007);

### *Chemical analysis*

The meat samples were analyzed to determine the dry matter, crude protein, crude fiber, ether extract and ash using methods described by AOAC (1995).

### *Statistical analysis*

Data collected were subjected to analysis of variance (ANOVA), the treatment means were separated using Duncan's Multiple Range Test using (SAS, 1995).

## Results and discussion

The result of the proximate composition of meat sample obtained from broiler chicken served acidified water is as presented on Table 1. Significant ($P < 0.05$) difference

was recorded for moisture content among all parameters evaluated. Highest ($P < 0.05$) values was recorded on $T_5$ (71.47) followed by $T_1$ (71.27) while $T_2$ (71.23), $T_3$ (71.10) and $T_4$ (71.14) had the least values respectively. This result agreed with the work reported by Ikeme (1990) but contradict the report of Paul Warries (2010) who reported moisture content of broiler meat ranges from 55- 60%.

The effect of acidified water on growth performance of broiler chicken showed no significant ($P > 0.05$) difference in the growth parameter measured but the values for final weight ranges from 1946.40 – 2380.30g/bird with $T_3$ (2% acetic acid) having the lowest value and the highest value was recorded on $T_2$(2% citric acid). Similar trend was observed for feed conversion ratio, although the values showed no significance but statistically $T_2$ had the highest value which shows that inclusion of citric acid orally at 2% enhance digestibility through their influence on gastrointestinal micro flora. This agreed with the findings of Atapattu and Nelligaswatta (2005) who reported increased feed intake when chickens are fed rice by-product with 2% CA. Previous study reported that dietary organic acids such as citric acid increase the body weight of the birds (Chowdhury *et al.,* 2009b). In this study, supplementation of organic acids in drinking water helps to reduce the level of pathogens in water, crop and the proventriculus, regulate the gut microflora, increase feed digestion and improve growth performance of birds (Philipsen, 2006).The non significant difference ($p > 0.05$) reported for final weight obtained in this study agreed with (Oyewole *et al* ., 2002) who reported no significant difference in final body weight when broiler chicken were served with acidified based diet. Numerical improvement in FCR was observed in T2 compared with other treatments. This is in agreement with the findings of Afsharmanesh *et al*. (2005) who found higher feed conversion with the administration of citric acid in poultry.

**Table 1: Proximate composition of meat sample from broiler chicken served acidified water**

| Parameters (%) | Control | 2% CA | 4% CA | 2% AA | 2% AA | SEM± |
|---|---|---|---|---|---|---|
| Moisture content | 71.27ab | 71.23b | 71.10b | 71.17b | 71.47a | 0.04 |
| Protein | 18.53 | 18.97 | 19.47 | 19.83 | 20.10 | 0.15 |
| Ether extract | 7.70 | 7.57 | 7.10 | 6.57 | 7.73 | 0.18 |
| Ash | 2.37 | 2.27 | 2.30 | 2.10 | 1.93 | 0.07 |
| Crude fibre | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.00 |
| Carbohydrate | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.00 |

CA: Citric acid; AA: Acetic acid

**Table 2: Growth response of broiler chicken served acidified water**

| Parameters | Control | 2% CA | 4% CA | 2% AA | 4%AA | SEM(±) |
|---|---|---|---|---|---|---|
| Initial Weight (g/b) | 172.08 | 170.60 | 185.07 | 173.30 | 173.07 | 3.99 |
| Final Weight (g/b) | 2193.50 | 2550.90 | 2131.50 | 2187.00 | 2243.70 | 70.39 |
| Weight Gain (g/d) | 2021.40 | 2380.30 | 1946.40 | 2013.70 | 2070.60 | 87.97 |
| Feed Intake (g/d) | 5464.80 | 6361.10 | 5442.60 | 5424.10 | 6786.60 | 250.85 |
| Feed Conversion Ratio | 2.71 | 2.67 | 2.80 | 2.70 | 3.28 | 0.16 |
| Water Intake (ml/b) | 253.01 | 228.73 | 227.06 | 219.83 | 234.04 | 11.46 |
| Mortality (%) | 7.41 | 11.11 | 0.50 | 0.00 | 18.52 | 3.19 |

CA: Citric Acid AA: Acetic Acid

The mean values for carcass analysis are presented in Table 3. The result obtained showed significant (P> 0.05) difference in drumstick, wings, neck, head, lungs and gizzard among all parameter measured. The insignificant P > 0.05 values observed in dressed weight and others are in well in agreement with the previous findings of Kahraman *et al. (*1997) where no significant effect was also observed. Highest (P< 0.05) value for drumstick was recorded on $T_2$ (11.17) followed by $T_1$ and $T_4$ (10.65 and 10.67) while the least values were obtained in $T_3$ and $T_5$ (9.54 and 10.10), respectively. This could be attributed to the level of inclusion or probably the type of organic acid used. Similar trend was observed for gizzard having the highest P< 0.05 value on $T_2$(2%CA). This result was contrary to the work of Islam *et al*. (2008) that carcass characteristics were not affected by supplementation of organic acids. Other research indicated numerical improvements in carcass yield in broilers fed 3% CA but not at a 6% level (Nourmohammadi *et al*., 2010).

Result obtained for meat quality attributes showed significant (P< 0.05) difference in cooking loss and chilling loss among all parameters measured as shown on Table 4. For cooking loss, (P< 0.05) value was recorded on breast muscle alone with $T_5$ having the higher value (26.91) and the least values on $T_1$,$T_2$, $T_3$ and $T_4$ (20.05, 22.56, 15.85 and 23.92) respectively whereas for chilling loss, significant (P< 0.05) difference were recorded on thigh and drumstick muscles. Higher P< 0.05 value for thigh muscle was on $T_1$ followed by $T_4$ and least values on $T_2$, $T_3$ and $T_5$respectively while for drumstick, $T_1$ and $T_4$ recorded the higher (P< 0.05) followed by $T_5$ then $T_2$ and $T_3$ had the least value. This showed that citric and acetic acid has effect on the quality of the meat.

**Table 3: Carcass quality of broiler chicken served acidified water**

| **Parameters (%)** | Control | 2% CA | 4% CA | 2% AA | 4% AA | SEM (±) |
|---|---|---|---|---|---|---|
| Live weight | 2416.70 | 2400.00 | 2400.00 | 2500.00 | 2600.00 | 39.78 |
| De-feathered weight | 92.42 | 94.74 | 88.33 | 91.78 | 90.08 | 1.21 |
| Eviscerated weight | 79.74 | 81.26 | 76.30 | 77.93 | 78.84 | 0.16 |
| Dressed weight | 70.15 | 72.07 | 66.69 | 67.72 | 68.99 | 1.04 |
| Breast | 23.04 | 25.00 | 22.86 | 22.82 | 23.54 | 0.51 |
| Drumstick | $10.65^{ab}$ | $11.17^{a}$ | $9.54^{b}$ | $10.67^{ab}$ | $10.10^{b}$ | 0.20 |
| Wings | $11.52^{a}$ | $8.78^{bc}$ | $8.63^{c}$ | $9.73^{b}$ | $10.45^{ab}$ | 0.35 |
| Back | 13.08 | 21.56 | 12.71 | 13.59 | 13.62 | 1.72 |
| Thigh | 10.43 | 11.34 | 10.33 | 9.85 | 10.14 | 0.23 |
| Shank | 3.97 | 4.30 | 3.64 | 4.97 | 3.90 | 0.12 |
| Neck | $3.03^{c}$ | $3.41^{b}$ | $4.62^{a}$ | $4.09^{ab}$ | $3.26^{bc}$ | 0.19 |
| Heart | 0.54 | 0.58 | 0.47 | 0.47 | 0.45 | 0.03 |
| Head | $3.01^{a}$ | $2.42^{ab}$ | $2.15^{b}$ | $2.09^{b}$ | $2.56^{a}$ | 0.41 |
| Gizzard | $2.89^{ab}$ | $3.11^{a}$ | $2.41^{b}$ | $2.70^{ab}$ | $2.47^{b}$ | 0.10 |
| Liver | 2.26 | 2.55 | 2.32 | 2.16 | 2.03 | 0.13 |
| Lungs | $0.57^{a}$ | $0.42^{b}$ | $0.40^{b}$ | $0.51^{ab}$ | $0.49^{ab}$ | 0.02 |
| Kidney | 0.43 | 0.39 | 0.40 | 0.43 | 0.41 | 0.03 |
| Abdominal pad | 0.69 | 0.52 | 1.16 | 0.71 | 1.02 | 0.12 |

$^{a,b,c}$ means along the same with different superscript are significant different (P<0.05)

CA: Citric acid; AA: Acetic acid

SEM- Standard error of mean

**Table 4: Meat quality of broiler chicken served organic acidified water**

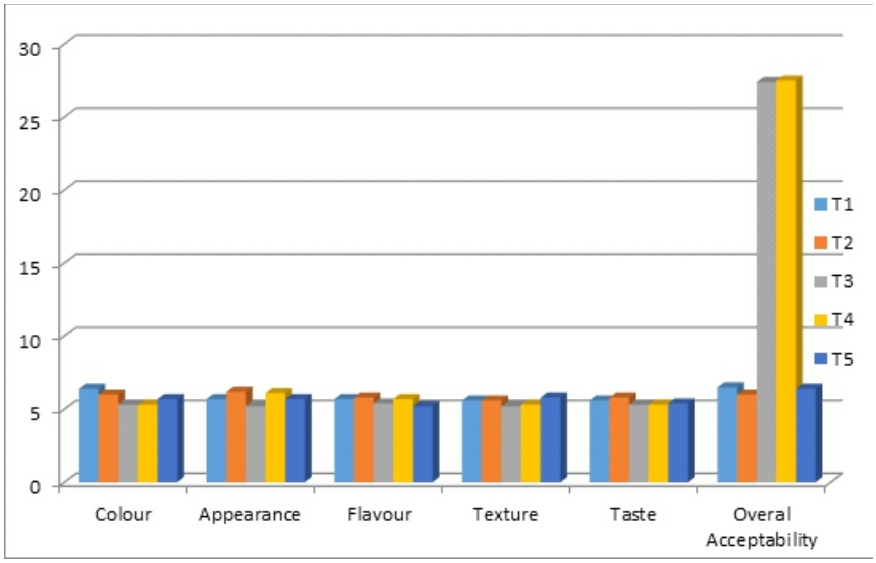
| Parameters | Control | 2% CA | 4% CA | 2% AA | 4% AA | SEM± |
|---|---|---|---|---|---|---|
| Cooking loss | | | | | | |
| Breast | 20.05$^{ab}$ | 22.56$^{ab}$ | 15.85$^{ab}$ | 23.92$^{ab}$ | 26.91$^{a}$ | 1.42 |
| Thigh | 23.87 | 24.00 | 28.42 | 25.56 | 23.01 | 1.99 |
| Drumstick | 19.98 | 21.87 | 21.27 | 21.68 | 17.15 | 1.50 |
| Chilling loss | | | | | | |
| Breast | 0.60 | 0.70 | 0.83 | 0.34 | 0.64 | 0.11 |
| Thigh | 2.62$^{a}$ | 0.95$^{b}$ | 0.41$^{b}$ | 1.57$^{ab}$ | 0.68$^{b}$ | 0.27 |
| Drumstick | 1.90$^{a}$ | 0.88$^{b}$ | 0.99$^{b}$ | 1.93$^{a}$ | 1.08$^{b}$ | 0.12 |
| Thermal shortening | | | | | | |
| Breast | 10.39 | 14.97 | 15.10 | 18.27 | 11.25 | 1.99 |
| Thigh | 2.92 | 9.84 | 15.59 | 9.40 | 14.99 | 2.29 |
| Drumstick | 4.68 | 11.76 | 6.09 | 5.80 | 10.57 | 1.54 |
| pH | 7.03 | 7.44 | 7.16 | 7.62 | 7.39 | 0.13 |

CA: Citric acid; AA: Acetic acid

$^{ab}$ Means in the same row with different superscripts are significantly ($p < 0.05$) difference.

SEM- Standard error of mean

The graphical presentation of the sensory evaluation of the drumstick, breast and thigh muscles from broiler chicken served acidified water were presented in Figures 1, 2 and 3 respectively. This represent the values obtained for color, appearance, flavor, texture, taste and overall acceptability for all the meat samples as judged by the panelist. Figure 1 showed similarity in the preference for all the parameters evaluated across the treatment mean except for overall acceptability which had greater preference in $T_3$ and $T_4$ respectively.




[4]**Fig.1: Sensory evaluation of drumstick muscle of broiler chicken served different acidified water.**

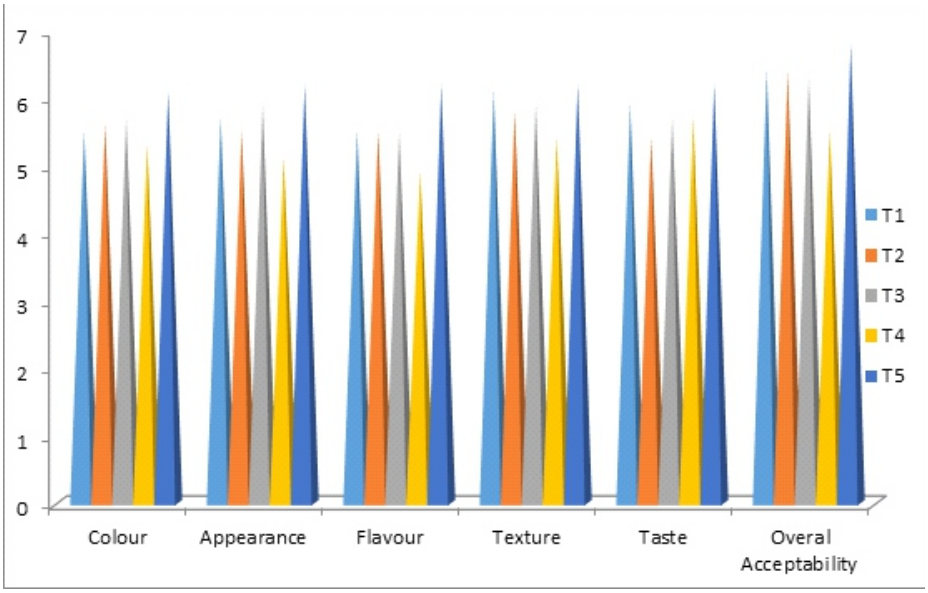



**Fig.2: Sensory evaluation of breast muscle of broiler chicken served acidified water**

Keys: $T_1$= 0% acid (Control) $T_2$ = 2% citric acid $T_3$= 4% citric acid

$T_4$= 2% acetic acid $T_5$ = 4% acetic acid

The graphical presentation of the sensory quality of breast muscle from broiler chicken served citric and acetic acid orally is shown in figure 2. This graph indicated that there are similarities in the values obtained for colour, appearance, flavor, texture, taste and overall acceptance for $T_1$ – $T_4$ respectively with an exception in $T_5$ which had a greater preference across the treatments as subjectively judged by the taste panelists. The highest values were recorded in $T_5$ for all the sensory parameters evaluated, while $T_4$had the least values. This finding is contrary to the result obtained by *Martin Mellenet et al. (2014)* who evaluated the sensory properties of breast meat from broiler chicken after application of different additives.

The sensory properties of the thigh muscle from broiler chicken served acidified water were graphically presented in Figure 3. This graph showed the panelist ratings for colour, appearance, flavor, texture, taste and overall acceptability across the treatment means with the score ranging from 5.20 – 6.80 from Treatment 1(control) – Treatment 5, respectively.

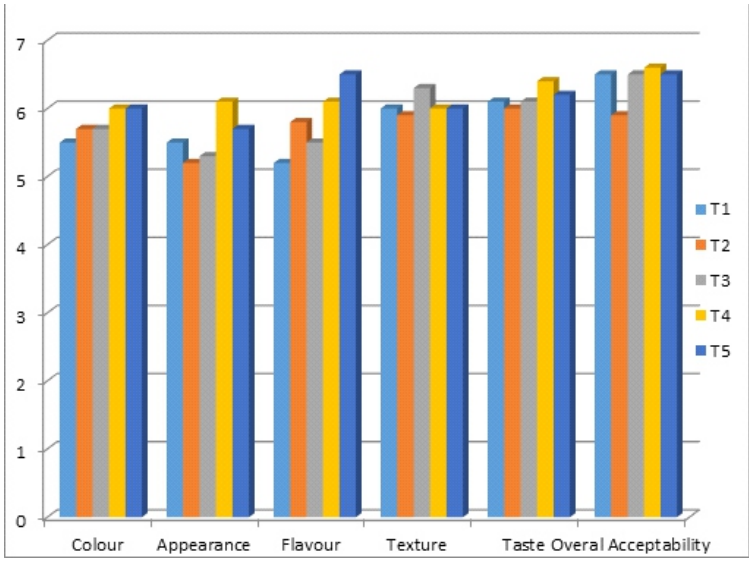



**Fig.3: Sensory evaluation of thigh muscle of broiler chicken served acidified water.**

Keys: $T_1$= 0% acid (Control) $T_2$= 2% citric acid $T_3$= 4% citric acid $T_4$= 2% acetic acid $T_5$ = 4% acetic acid

## Conclusion

From the results of this study, it can be concluded that the inclusion of citric and acetic acid orally for broilers had no detrimental effect on growth performance but enhance the quality of the carcass.

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