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Efficacy of Human Oral Rehydration Salt Solution during Fasting on the Meat and Sensory Characteristics of Broiler Chicken

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Abstract:- Broiler undergoes fasting before slaughter increases water and electrolyte K+ and Na+ excretion, which affects the quality and sensory characteristics of chicken meat. The present study was initiated to determine the efficacy of human Oral Rehydration Salt (ORS) vs. tap water on the meat quality and organoleptic characteristics of broiler chicken undergoing different levels of hour fasting. A 2 x 3 factorial ANOVA in CRD was used to analyze the gained data out of 18 heads broiler chickens slaughtered and processed for analysis. Data showed no significant (P < 0.05) effect of oral rehydration salt (ORS) and interaction of Drinking water x Hour fasting on pH of meat and percentage cooking loss while statistically significant to the main effect of hour fasting (P > 0.05). Mean values of organoleptic characteristics viz. odor, appearance, taste, and juiciness were not significantly affected by ORS treatment and levels of hour fasting. However, significant interactions (P < 0.05) effects on meat texture and overall acceptability. The quality of broiler chicken meat normalizes up to 48 hours of fasting with moderate acceptability scored by consumers. The overall effect of ORS treatment in water before and after fasting on meat quality and sensory attributes was comparable to tap water therefore not recommended. Further verifications for sensory testing should be performed between trained and untrained panelists using the 9-point hedonic scale to clearly distinguish differences between sensations.

Keywords:- *Oral Rehydration, Feed Withdrawal, Fasting, Broiler, Organoleptic, and Meat Quality.*

I. INTRODUCTION

Chicken meat has relatively lower fat and cholesterol levels; it is acknowledged as a healthful food option compared to red meat (Jaturasitha, Kayan, & Wicke, 2008). Poultry provides several advantages than red meat resulting in increasing demand for chicken meat; it has a lower price, cuts are easier to handle, and the meat is correlated with fewer religious restrictions (De Liu *et al.*, 2012). However, their qualities and advantages over red meat are compromised due to the mishandling of broilers chicken during the pre-harvest time. Usually, before slaughtering of birds, while they are still on the poultry cages, their feed is removed and they undergo fasting that aims to minimize the contents of gastrointestinal tracts, and subsequent contamination of the carcasses by fecal matter during transport and evisceration (Contreras-Castillo *et al.*, 2007). Pre-Slaughter factors that can affect poultry meat quality. Komiyama *et al.*, (2008) reported that meat pH was significantly different (P=0.05) by the different feed withdrawal period. Cooking loss and meat pH values were inversely correlated. As the pH of meat decreased, the quality of the final produce increased because the cooking losses were less. Meanwhile, consumers are interested in the appearance, aroma/odor, taste, texture, and sound, which are all quality characteristics measured by the use of the senses. These characteristics may also serve as references during the selection of foods (Lyon & Lyon, 2000).

Broiler undergoes fasting before slaughter is a stressful situation that increases water and electrolyte K+ and Na+ excretion, which affects the quality and sensory characteristics of chicken meat. Nutritional interventions have been useful to mitigate the adverse effect of such situations. In humans, patients are treated with oral rehydration therapies (ORT), which are fluids having electrolytes and sugars to induce water uptake in the gut and to remunerate the body for water loss and electrolytes, particularly Na and K (Rao, 2004). Some of the symptoms are experienced by humans having gastrointestinal troubles are alike to those experienced by chickens under heat stress and fasting, normally water and electrolyte loss.

However, basic information about the descriptive sensory quality attributes of broiler chicken undergoing ORT during feed withdrawal is poorly documented. Hence, the main objective of this study was to determine the alleviatory factor of ORS on the adverse effects of fasting on the meat quality and sensory characteristics of broiler chicken.

II. MATERIALS AND METHODS

A total of ninety (90) heads of marketable size commercial broiler of almost similar weight were selected randomly and divided into 2 groups (group 1: water with ORS; group 2: tap water). The birds in every group were further divided into 3 sub-groups (sub-group 1: 0-h fasting; sub-group 2: 24-h fasting; sub-group 3: 48-h fasting) replicated 3 times holding 5 birds each conducted at Surigao State College of Technology-Mainit Campus (SSCT-Mainit) Poultry House.

The human ORS (Hydrite by Amherst Lab. Inc.) was dissolved in water at a ratio of 1 pack (4.1 g) per 300 ml water. The solution contains 5.00 mmol Sodium, 1.33 mmol Potassium, 4.33 mmol Chloride, 0.76 Citrate, and 5.00 mmol Glucose per liter of water which was given to the treatment group starting in three days before fasting. Feeds were removed totally during fasting while drinking water (ORS and tap water) remained until slaughter time. Water in a plastic container was securely tied via a plastic cord attached to the cage wall.

One (1) chicken close to average per cage were slaughtered and processed according to assigned slaughtered time (0-h, 24-h, and 48-h). The slaughtering was done by head dislocation, evisceration, and immediately transported to SSCT-Mainit Campus Food Laboratory and chilled for two hours at 0.5 ^{0}C before the preparation of meat samples for analysis.

Ten grams of breast meat samples from each group were ground for pH determination using the digital pH meter (PH-108) by insertion of the pH glass electrode into the center of the clear glass cups with blended meat samples. Beforehand, the pH-meter was calibrated using standardized buffers of pH 4.0, 6.9 as mentioned by Siekmann *et al.*, (2018). The 10 grams ground meat was placed in a blender mixed with 100 ml distilled water and blended for 30 seconds on high speed. Blender cups and pH electrode was rinsed with distilled water between each sample, while acetone from a squeezed bottle was used periodically to clear pH glass electrode from fat build-up. A duplicate process was performed in every determination.

Cooking loss (CL) percentage determination following the methods of Honikel, (1987). Ten (10) grams of broiler breast meat were oven-dried. The sample was subjected to internal temperature to as high as 150 ^{0}C for 1 hour or until the weight of the samples became stable and the meat samples were removed from oven drier and let to cool for 30 minutes or until it came back to normal temperature. Weight of samples was recorded before cooking (RW), and after cooking, cooked weight (CW) to determine the cooking loss (CL) percentage using the following equations.

Cooking loss (%) = [(weight of raw chicken meat (g) − weight of cooked chicken meat (g)) / weight of raw chicken meat (g)] x 100

Broiler chicken breast meat samples were prepared to determine the effects of ORS during feed fasting on sensory characteristics. The meat was steamed for 30 minutes without any seasonings and spices. The steamed meat samples were sliced to 10 grams according to treatments and placed in a disposable plastic cups ready for evaluation by ten (10) man consumer and untrained sensory panel using the five-point hedonic scale. The order of serving was randomized and numbered according to Appendix A. Table of randomization by Kwanchai & Arturo, (1984). Appropriate score sheets were provided for the sensory test. The panelists cleansed the palate by drinking water after every sample.

The sensory characteristics of chicken breast samples were rated based on consumer perceptions using the 5 points hedonic scale. The 10 man consumer panelists were composed of faculties, staff, and students of SSCT-Mainit campus with no known history of vices of cigarette smoking and false teeth. Before testing, the panelists have oriented the 5 five-point hedonic scales with corresponding scores viz. extremely acceptable (5), moderately acceptable (4), acceptable (3), moderately unacceptable (2), and unacceptable (1). Sensory attributes like odor, appearance, texture, taste, overall acceptability and juiciness definitions for descriptive sensory analysis were available for each panelist upon evaluation.

- Odor/Aroma- the intensity of smell (meaty, stable-like, metal-like, blood-like, and smell of dung) in the samples by smelling on the bottom side of the sample.
- Appearance – color intensity e.g., the intensity of color, size of visible fibers by evaluating the surface of the samples.
- Texture – adhesiveness e.g., coherence while chewing and adhesion to the molars by chewing with the molars 3 to 3 times.
- Taste – the intensity of taste e.g., the intensity of sweetness, sour, bitterness and salty by evaluation after seven to ten chews with the close mouth.
- Juiciness – the amount of juice by chewing with the molars two to three times.

All attributes were scored as high as (5) extremely acceptable, (4) moderately acceptable, (3) Acceptable, (2) moderately unacceptable, and (1) unacceptable.

III. RESULTS

As shown in Table 1 an analysis of the pH of broiler chicken breast meat means reveals no statistical difference between the marginal pH means for ORS and tap water groups (M = 6.16, SD = 0.21 vs. M = 6.02, SD = 0.15). The marginal pH means of the hour fasting are significantly different (M = 6.09, SD = 0.18 vs. M = 6.07, SD = 0.15 vs. M = 5.94, SD = 0.15) with the mean for "48-hr" being the highest and the mean for "0-h" as the lowest while the mean of "24-hr" fasting is intermediate and not significant to either 48-hr or 0-hr fasted chickens.

Drinking water	Hour fasting			Marginal
	0hr	24hr	48hr	
Tap water	5.99 ± 0.15	6.12 ± 0.21	6.38 ± 0.09	6.16 ± 0.21[ns]
ORS	5.90 ± 0.17	6.07 ± 0.12	6.09 ± 0.13	6.02 ± 0.15[ns]
Marginal	5.94 ± 0.15[a]	6.07 ± 0.15[ab]	6.09 ± 0.18[b]	

Table 1:- Mean of Meat pH of Broiler Chicken Breast Meat

Marginal row and column mean with the same letter in their superscript are not significantly different from one another.

Treatment	Weight of cooked meat (g)	Cooking loss (%)
Hour fasting		
0 hour	4.24 ± 0.40[a]	57.6 ± 4.02[a]
24 Hours	4.58 ± 0.19[ab]	54.15 ± 1.99[ab]
48 Hours	4.91 ± 0.37[b]	50.93 ± 3.68[b]
Drinking water		
ORS	4.59 ± 0.38[ns]	54.08 ± 3.81[ns]
Tap water	4.56 ± 0.48[ns]	54.36 ± 4.81[ns]

Table 2:- Cooking Loss and Percentage Cooking of Broiler Chicken Breast Meat

Values within the same column with the same superscript are not significantly different (p > 0.05)

Treatment	Odor	Appearance	Texture	Taste	Juiciness	Overall Acceptability
Hour fasting						
0-h	4.33[ns]	3.83[ns]	3.53[ns]	3.76[ns]	3.80[ns]	3.73[ns]
24-h	3.93[ns]	3.83[ns]	3.60[ns]	4.02[ns]	3.83[ns]	3.53[ns]
48-h	3.80[ns]	3.73[ns]	3.83[ns]	4.20[ns]	3.93[ns]	3.60[ns]
Drinking water						
ORS	4.02[ns]	3.80[ns]	3.73[ns]	3.97[ns]	3.83[ns]	3.70[ns]
Tap water	3.82[ns]	3.75[ns]	3.75[ns]	3.56[ns]	3.71[ns]	3.53[ns]

Table 3:- Summary of Sensory Attributes in Drinking Water and Levels Hour Fasting

[ns:] Not significantly different $P > 0.05$

The data of cooked meat and cooking loss of broiler chicken meat were analyzed with a 2 x 3, Drinking water x Hour fasting, factorial ANOVA Table 2. The weight cooked meat and percent cooking loss have significant ($P < 0.05$) effects found for the main effect of hour fasting. But the main effect of drinking water fall short of statistical significance, and Drinking water x Hour fasting interaction, ($P > 0.05$) on the weight of cooked meat and % cooking loss. Meanwhile, the two parameters are exactly contrasting in the mean values pattern. As shown in Table 2, the weight of cooked meat are significantly highest in "48-hr" fasted ($M = 4.91$, $SD = 0.37$) followed by "24-hr" ($M = 4.58$, $SD = 0.19$) fasted and the lowest are "0-hr" fasted ($M = 4.24$, $SD = 0.40$) compared to the percentage cooking loss, the highest are in "0-hr" fasted ($M = 57.06$, $SD = 4.02$) followed by "24-hr" fasted ($M = 54.15$, $SD = 1.99$) while the lowest are "48-hr" fasted ($M = 50.93$, $SD = 3.68$).

The summary of different organoleptic characteristics as affected by drinking water treatments and levels of hour fasting is shown in Table 3. All attributes viz. odor/aroma, appearance, texture, taste, juiciness, and overall acceptability have no significant differences by the main effects of drinking water and feed withdrawal period ($p > 0.05$), but drinking water interacts to the meat texture and overall acceptability in levels of hour fasting ($p < 0.05$).

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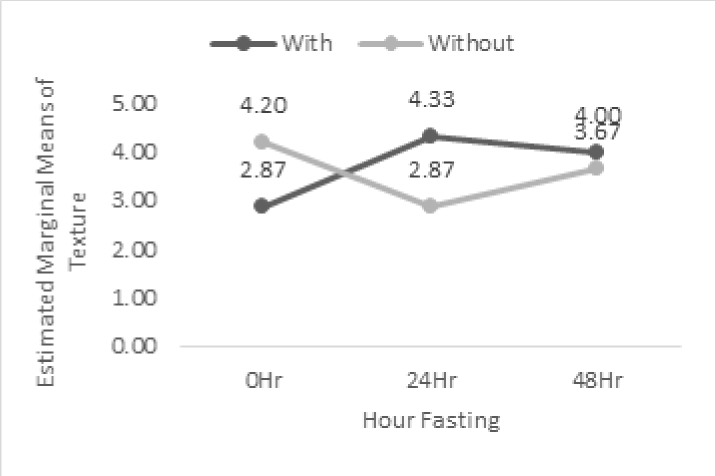

Fig 1:- Levels of Scores for Meat Texture

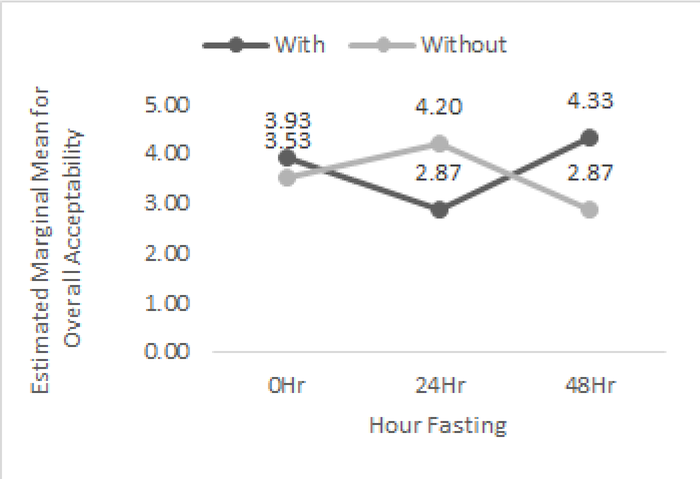

Fig 2:- Levels of Scores for Overall Acceptability

All experimental data were subjected to two-way analysis of variance (ANOVA) for Complete Randomized Design (CRD) using SPSS version 20. Least square means were compared by the Tukey HSD test. All statements of differences were based on = significance at p 0.05.

IV. DISCUSSION

The rate and levels of pH reduction are the main determining factors of meat quality Van Laack, (2000). Table 1 shows a higher pH of meat is detected in 48-hr fasted followed by 24-hr and 0-hr fasting chickens. Ngoka & Froning, (1982) indicated that feed withdrawal has a significantly altered meat final pH, water retention capacity, live weight and moisture content of turkey breast muscle when compared to the fed group. After slaughter, when the muscle is transformed into the meat, anaerobic glycolysis results in a pH decline. Our study found a significant pH decline in non-fasted chicken resulted from high glycogen levels at slaughter because they are unfasted. If the glycogen reserves are depleted before slaughter, the ultimate pH does not fall to 5.3-5.6. It remains high at 6.8, (Greaser, 1986). Fasting or inadequate feeding in the period of pre-slaughter lowers glycogen reserves. Ultimate pH is determined largely by levels of muscle glycogen at death. They stressed that the formation of lactate declines pH (Greaser, 1986).

The weight of cooked meat in this experiment was determined by the weighing of cooked samples after oven drying. Data shows the significantly higher weight of cooked meat on 48-hr fasted and lower in 0-hr fasted while the 24-hr fasted is intermediate and not significant to both 48-h and 0-h fasted chickens.

Cooking loss and pH of meat values are positively correlated. As the pH decreased, the quality of the final produce increased because the cooking losses were less (Contreras-Castillo, 2007). Moreover, loss of weight during cooking of meat is a result of water and fat loss. After heating the muscle fiber protoplasm coalesces which results in contraction of fiber and muscle cell (Price, 1971). In comparison to our findings, the higher percentage of cooking loss was in 0-hr fasted chicken because they had lots of water and fats since they have not fasted. Furthermore, pre-harvest fasting for 24-hr would result in cooking yield increase of 1.6% compared to 18-hr, which confirms the correlation (r=0.7 to 0.8) between ultimate meat pH and technological yield of cooked hams (Monin, 1988). A higher ultimate pH (pHu) is related to a darker color, reduced drip loss (higher WHC and WBC) and tougher meat (Warner, 1994; Pearson & Young, 1989). Pale breast meat of broiler has a lower water-holding capacity, causing in 8-10% reduction in cooking yields (van Laack et al., 2000). Pale colored meat and low WHC correlate with a lower in ultimate pH. Ultimate pH of pale broiler breast meat approximately 5.70 versus 5.96 in normal-colored breast meat (van Laack et al., 2000).

V. SENSORY

The sensory attributes like odor/aroma, appearance, texture, taste, juiciness, and overall acceptability of steamed broiler meat samples were rated by consumer and untrained sensory panel using the 5-point hedonic scale. Husson & Pagès, (2003), the analyses of variance show that the two types of juries (trained and untrained) give similar sensory profiles and the few differences are mainly due to different ways of using the scale. Comparing the differences among the averages of the scores of different attributes it shows no significant effects by all levels of hour fasting (Table 4) having scores ranging from 3.53 to 4.33. However, the 0-h fasted has found highest in odor, appearance, and overall acceptability, while lowest in texture, taste, and juiciness equivalent to Contreras-Castillo, (2007) no differences in juiciness for the different FW periods, so this attribute did not interfere with the tenderness scores. Lyon, Smith, Lyon, & Savage, (2004), noticed that fasting did not alter the flavor attribute; nonetheless, meat from birds at 0 h fasting was darker and redder. The flavor was not tested in the entire study but it was observed darker and redder in appearance in 0-h fasting. Smith, Lyon, & Lyon, (2002) found that feed withdrawal produced lighter and less red broiler breast meat. Further, fillets from 8-h FWD birds had significantly higher L* values (lighter) whether cooked or uncooked and continued the trend of lighter fillets resulting from feed withdrawal stress.

The meat texture, taste, and juiciness of 48-h fasted chickens are of a similar trend wherein the better texture the samples are, the juicier and tastier they become. Diet and fasting significantly altered sensory texture (Lyon, Smith, Lyon, & Savage, (2004).

Having scores average ranging from 3.53 to 4.02, the presence of ORS did not manifest significant effects on all sensory attributes of broiler chicken meat over the tap water group in conformity with the findings of Schaefer, Murray, Tong, Jones, & Sather, (1993), both oral potassium and intramuscular magnesium aggravated subjective pork structure and texture scores but was found to improve muscle brightness and hue (higher b* value). The result reflected that ORS treatment was brighter in color as it was scored higher values on appearance (3.80) over tap water (3.75) Table 3.

Testing on the interactions of these factors, the different levels of hour fasting versus drinking water showed significant interactions in terms of texture and overall acceptability. This then implies that the effect of levels hour fasting on texture and overall acceptability of steamed broiler meat is dependent on treatment in drinking water and vice versa. Figures 1 and 2 show the graphs of these interactions respectively. It can be argued that the comparability of all sensory profile scores may be attributed to the failure of untrained testers to use the scale correctly. Further study should be made on sensory of meat to be done by a trained panelist probably using the 9-point hedonic scale to clearly distinguish differences between sensations.

Overall findings in this proceedings disclosed that the ORS treatment before and after fasting regimes did not improve or inhibit the adverse effect of feed withdrawal which aligned to the conclusions of Schaefer, Murray, Tong, Jones, & Sather, (1993), that oral potassium and intramuscular magnesium, as provided in the present study, had no advantageous impacts on pork quality but that the beneficial effects of Magnesium Aspartate on meat color and drip loss may warrant further investigation.

VI. CONCLUSION

In conclusion, the treatment of human Oral Rehydration Salt in water before and after fasting regimes was not sufficient to improve or inhibit the adverse effect of feed withdrawal.

The recent study found that the optimum feed withdrawal period of broiler whether with or without ORS before the slaughter could go as far as 48 hours with beneficial effects to the pH of meat and reduced cooking loss which is an indicator of good quality meat sought after by broiler meat buyers. The comparable results of sensory and consumer's acceptability from acceptable to moderately acceptable levels of meat from broiler revealed that the odor, appearance, texture, taste, juiciness and overall acceptability in zero to 48 hours fasted chicken remain stable and acceptable to the consumers.

Further verifications sensory testing should be performed a larger number of trained panelists using the 9-point hedonic scale to clearly distinguish differences between sensations.

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