The Effect of Substitution of Groundnut Cake by Water Melon Seed Cake (Citrullus Lanatus) in Ration for Lamb Fattening in Sudan

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Abstract: The present study was conducted to evaluate water melon (Citrullus lanatus) seed cake as a possible protein supplement for growing lamb in comparison to groundnut cake. Graded proportion of water melon seed cake (WMSC) (0, 25, 50, 75, 100%) which replace groundnut cake (GNC) were incorporated in five diets iso-caloric, iso-nitrogenous diet for lamb. Diet A contained 0% proportion of WMSC, diet B, C, D and E contained 25%, 50%, 75% and 100% WMSC proportions respectively. Forty five yearling male lambs of Sudan desert sheep ecotype Kabashi with average body weight of 31.5 kg were used. Carcass composition parameters did not differ significantly among the treatment groups. Muscle and fat percentages were slightly higher in the control group. But bone percentage was higher in group E which had given higher percentage of WMSC. The slaughter by-products showed no significant differences among dietary treatments. Chemical composition of meat revealed that the protein content in the muscles of all treatment groups except group E had similar values. Group A had the highest (P < 0.01) fat and lowest moisture content, while group E had the lowest fat content and highest moisture content. Fat content was decrease with increasing level of WMSC inclusion in the diet, while moisture content increases with it increasing level. There is a significant effect (P < 0.01 and P < 0.05) among treatment groups for sacroplasmic proteins and non-protein nitrogen respectively, but there was no significant effect was observed for myofibrillar proteins. The values of these proteins were decreased with increasing dietary level of WMSC. Meat quality attributes showed significant effect for water holding capacity (P <0.001), cooking loss (P < 0.01) and shear force (P < 0.001) indicated that meat of group A was of superior water holding capacity and lower cooking losses, so it was more tender than the other groups. The meat colour revealed significant (P < 0.05), (P < 0.01) and (P <0.001) effect among dietary treatments for lightness, redness and yellowness respectively, indicated that group C, D and E were darker in colour than group A and B. Dietary treatments showed no significant effect among the tested groups for taste panel scores of tenderness, juiciness, flavour, colour and overall acceptability. However, meat from animals in group A was desired more than the meat from other groups. There is a significant effect (P < 0.01 and P < 0.05) among treatment groups for sacroplasmic proteins and non-protein nitrogen respectively, but there was no significant effect was observed for myofibrillar proteins. The values of these proteins were decreased with increasing dietary level of WMSC. It could be concluded that WMSC when incorporated in lamb diets produces carcasses which were significantly not different from that produced by GNC diet. Meat muscle composition and quality was also had a tendency to be similar to that of the GNC diet.

Key words: water melon (Citrullus vulgaris) seed cake in lamb fattening.

INTRODUCTION

World demand for animal protein is growing continuously\(^{(12)}\). Increasing human population and improved standard of living, together with increased animal protein consumption in some developing countries, necessitated increasing animal production throughout the world. The main reason for the present low consumption of animal protein in the poor countries is low livestock productivity rather than low livestock numbers\(^{(33,54)}\).

Livestock industry is of great importance to Sudanese economy as it is one of the main sources of food, employment and foreign currency. Sheep population is estimated at 49,797 million heads\(^{(100)}\). In recent years, Sudanese sheep namely Sudan desert type, has receive great interest as an export commodity to the Arab countries. In 2000-2001 for example, sheep
exports has contributed $261.34 million to the national exchange earnings at an annual off take rate of 21.778 million heads. 

Protein is an expensive component in animal rations and one that may be in short supply especially in developing countries. This shortage is very critical in both human and animal nutrition. One of the critical pressing problems today is how to augment the shortage of protein in diets.

Recently a new strategy for alleviating food shortages is now being actively developed. This strategy aimed primarily at reducing or eliminating man-animal competition for the already in adequate agricultural products, through the development of novel feed material unsuitable for human use, and fed exclusively to livestock. The resulting sparing effect on traditional agricultural products routinely eaten by man should alleviate the present food scarcity experienced by many developing countries.

Oil seeds, cereal grains and pulses are the three groups of plants which supply most of the protein in the world. Among the different vegetables and crops known oil seeds are the most promising, economic, acceptable, and safe type crops for protein production. In fact, oil seeds by-product of the oil industry require a minimum of processing, have good biological value, and are relatively free from anti-nutritive factors and fermentable sugars.

Conventional oil seeds cakes in the Sudan include groundnut, sesame, cotton and sunflowers seed cakes. The relative abundance of these by-products offers a unique opportunity for fast improvement of animal production in the country. Unfortunately, there are constraints facing their efficient utilization, these include export of these products, human nutrition, food industry and poultry nutrition. These facts necessitate seeking other potential feed stuffs that can replace conventional oil seed cakes.

Water melon (Citrus Vulgaris, Schrad) is a creeping annual cash crop which belongs to the family cucurbitaceous. It grows successfully in the tropics and sub-tropics. In Sudan water melon is locally known as “Batteikh” and is cultivated everywhere, particularly in the western parts of the country.

Water melon is extensively utilized in many parts of the country especially in Darfur and Kordofan regions. The melon watery juice is considered in many dry areas as a water substitute. Whole melon seeds are roasted and consumed as a popular snack “Tasali”. Melon seeds have been exported to some Middle Eastern and Arab countries. Water melon seeds are rich in oil and protein. The seeds are mechanically pressed for oil extraction. Melon seed oil proved to be a good source of high quality edible oil characterized by low free fatty acid content. The seed cake which is the byproduct of the extracted seeds is used as a protein supplement for livestock. The experience with water melon seed cake or meal in rations for fattening livestock showed that water melon seed cake is a good source of digestible protein, which is comparable to other oil seed cakes like cotton, linseed, etc. It can be safely incorporated in the animal feeds.

The Objective of this Study Is To: Evaluate the effect of feeding water melon seed cake on carcass characteristics and meat quality.

MATERIAL AND METHODS

Source of the Cake: The cake was brought from El-Mursala oil presser Khartoum North Factories Area.

Experimental Animals: Forty five male lambs of Sudan desert sheep ecotype Kabashi were utilized. Animals were selected according to their age 9-12 months) and weight which was approximately 31.5 kg. The lambs, ear tagged and given an adaptation period of two weeks.

Adaptation Period: During this period animals were fed groundnut halum and a mixture containing equal percentages of the assigned experimental rations ad libitum. The halum was gradually withdrawn during the first 7 days, while the ration mixture feeding continued till the end of the adaptation period.

Spraying with and a caricide solution against ecto parasites and deworming with Thiabenzole as a drench solution was performed. The Thiabenzole treatment was repeated after 15 days.

Experimental Procedure: Immediately after the adaptation period the animals were individually weighed and then randomly divided into five groups (A, B, C, D and E) of similar number and weight. The five groups were separately penned. Each pen was provided with watering and feeding facilities.

Feeds and Feeding: Five iso-caloric, iso-nitrogenous diets containing graded levels of water melon seed cake (0, 25, 50 75 and 100), which replace groundnut cake were used. The other ration ingredients were sorghum grain, groundnut cake, wheat bran, groundnut hulls, salt and lime stone. The chemical analysis, ingredient proportion and calculated chemical analysis of water melon seed cake and experimental diets are given in Tables 1 and 2. The diets were then randomly assigned to each animal group.

During the feeding period, animals were fed the assigned diets ad libitum. The diets were offered in one
meal at 8.00 a.m. throughout the study period which extended for 45 days. Green fodder (Medicago sativa) was also offered at a rate of one kg/head/week to avoid vitamin A deficiency. Clean water and salt lick were available throughout the experimental period.

Data Recorded:
Slaughter Procedure and Slaughter Data: At the end of the experimental period, five lambs were randomly taken from each group and transported to Department of Meat Production for slaughter. Slaughter weights were taken after an overnight fast except for water. The animals were slaughtered following the local Muslim Practices i.e. by severing both the jugular veins, carotid arteries and esophagus by a sharp knife without stunning when complete bleeding was attained; the head was removed at the atlantooccipital joint.

The lambs were skinned and then eviscerated. The skin, feet as well as the thoracic and visceral organs were individually weighed. Gut fill was determined as the difference in weight between the full and empty alimentary tract. The kidneys and kidneys Knob channel fat were left intact in carcass. The carcasses were weighed warm and then chilled at 4°C for 24 hours, the cold carcasses were reweighed. The tail was removed at its base and weighed. The kidneys and kidney Knob channel fat were removed and weighed. The carcasses were then halved along the vertebral column into left and right sides. The left side was weighed and broken into whole sale cuts according to M.L.C.[18].

Samples for Chemical Analysis and Quality Determination: Longissimus dorsi muscle samples were taken from loin joint. Samples were kept in polythene bags and frozen stored a waiting chemical analysis. Semi membranous muscle was also removed from both sides of the carcass. Each muscle was freed from external visible fat and connective tissues and utilized for meat colour determination, and subsequently frozen stored for shear force and connective tissue strength determinations.

Quality Attributes:
Objective Evaluation:
Water-holding Capacity (W.H.C.): Samples weighing about 0.3 gm from the minced L. dorsi muscles were used. Each sample was placed on a humidified filter paper (What man No. 1) kept in a desicator over saturated kcl solution and pressed between two plexiglass plates for 3 minutes at 25 kg load. The meat film area was traced with a ball ben and the filter paper was allowed to dry. Meat and moisture areas were measured with a compensating planometer.

The resulting area covered by the moisture was divided by the meat film area to give a ratio expressed as water holding capacity of meat. A larger ratio indicates an increase in the watery condition of the muscle or a decrease in water holding capacity[19].

W.H.C. = loose water area — meat film area

Meat film area

Colour Determination: Colour was determined on the semi-membranous muscles. Each muscle was allowed to oxygenate for half an hour at 4°C before colour determination.

Hunter colour components L (lightness), a (redness) and b ( yellowness) were recorded using Hunter lab Tristimulus colour Meter (D252). Subsequently these samples were frozen for cooking loss and shear force determinations.

Cooking Loss Determination: Semi-membranous samples were thawed at 4°C for 24 hour, placed in plastic bags in a water bath at 80°C for 90 minutes, muscle samples were then cooled in running water, dried from fluids and reweighed. Cooking loss was determined as loss in weight during cooking and expressed as a percent of pre-cooking weight.

Cooking loss W1 — W2 x 100

W1

Where:
W1 = weight before cooking
W2 = weight after cooking

Shear Force and Connective Tissue Strength: For shear force and connective tissue strength determinations, an Instron model 1000 fitted with a Warner Bratzler Shear device was used. Rectangular meat samples having across sectional area of 1 cm² were shorn across the muscle fibres. Cubical meat samples (1 x 1 x 1 cm) were also cut from cooked meat and used to determine connective tissue strength by shearing along the muscle fibre. Shear force and connective tissue strength were taken as the means of several determinations.

Protein Fractionation: The fractionation procedure was as described by Babiker and Lawrie[19]. All fractionation procedures were carried at 4 °C temperature. A 5 gram sample was weighed, put into a micro-blender jar maintained in a nice bath and 50 ml of cold 0.03 M potassium phosphate buffer (pH 7.4) was added. The contents of the micro-jar were blended at a low speed for 5 minutes. After
homogenisation, the homogenisate was transferred to 100 ml centrifuge tubes and centrifugated for 20 minutes at 3500 (r.p.m). The supernatant was kept and the residue was resuspended in another 50 ml of the same potassium phosphate buffer, homogenised and centrifuged as before. The supernatant was cooled and the two solutions obtained were combined and filtered through filter paper (Whatman No. 4) to remove fat and other particles not removed by centrifugation. The combined filtrate contained both sarcoplasmic proteins and nonprotein nitrogen fractions. Sarcoplasmic proteins were determined on 1 ml sample of this filtrate using Biuret method[63].

A 30 ml sample of the above filtrate was mixed with 10 ml of trichloroacetic acid 20% (wlv) for 15 minutes and filtered through filter paper (Whatman No. 1) to obtain non-protein nitrogen. Kjeldhal semi micro method was used to determine the nitrogen content of this fraction which was then expressed as a percentage of meat sample weight.

The residue remaining from the extraction with phosphate buffer was extracted once with 50 ml cold 1.1 MK1 in 0.1 M potassium phosphate buffer (pH 7.4) using the same method of sarcoplasmic proteins extraction. After centrifugation at 3500 (r.p.m) for 20 minutes. The supernatant was filtered through glass wool and the filtrate was used for myofibriller proteins determination by Biuret method[63]. Bovine serum albumin was used as standard for making the calibration curve. The result was expressed as percentage of meat sample weight.

**Subjective Evaluation:**

**Taste Panel:** Sensory panel sessions were conducted to compare some selected sensory properties of the five treatments. The frozen meat samples (L. dorsi muscle) form each treatment were thawed for 24 hours in a refrigerator (4 °C), the samples were then cut into equal pieces and wrapped individually in aluminum foil and roasted in an oven at 180°C for 60 minutes. The cooked samples were then cut into pieces and served warm.

Twenty five samples from the five treatments were evaluated at each session by semitrained panelists[156,33]. Panelists were instructed to record their responses for each attribute (tenderness, juiciness, flavour, colour and overall acceptability) according to a special scale (Appendix).

**Chemical Analysis:** Chemical analysis of protein, fat, ash and water content of the minced meat samples were carried out according to the methods of AOAC[1].

**Statistical Analysis:** All experimental data were analyzed using simple randomized design and Duncan Multiple Range Test was used to detect difference between means[149].

### RESULTS AND DISCUSSION

**Carcass Yield and Characteristics:** Carcass yield and characteristics of experimental lambs are shown in Table 5. No significant differences among the treatment groups were observed for slaughter weight, hot carcass weight, cold carcass weight, empty body weight, dressing-out percentage (on slaughter weight or empty body bases) and chiller shrinkage.

Gut fill percentage was not significantly different among the treatment groups. Maximum gut fill (20.08%) was found in group E and minimum gut fill (16.97%) was found in group A.

Carcass composition did not show any significant differences among treatment groups. Generally, inclusion of WMSC reduced carcass muscle and fat but increased carcass bone and trim.

Eye-muscle area (cm2) showed no significant differences among the experimental groups. Animals in group A has the largest eye-muscle area (12.45 cm2) while animals in group E recorded the least eye muscle area (11.0 cm2).

**Non-car cass Components:** Non-car cass components expressed as percentage of empty body weight are given in Table 6. No significant difference was observed among the experimental groups for head, skin, for feet, heart, lung and trachea, intestine (empty), liver, spleen, kidneys, kidney knob and channel fat, reproductive organs, omentum fat and mesentric fat.

**Whole Sale Cuts Yield:** The whole sale cuts of the experimental lambs from cold carcass are shown in Table 7. The proportion of the various whole sale cuts obtained from the carcass sides of the experimental lambs as leg and chump, single short forequarter, loin, best end of neck, breast and neck were not significantly different among the treatment groups. The tail weight though not significantly different among the treatment groups, but tend to decreased with the increase the inclusion level of WMSC.

**Joint Composition:** Joint composition of the experimental lambs expressed as percentage of joint weight are presented in Table 8. No significant difference among the treatment groups was observed for all joint composition.
Meat Chemical Composition: Meat chemical composition data of experimental lambs are shown in Table 9. There were significant differences among treatment groups in percentages of fat, ash, sarcoplasmic proteins and non protein nitrogen. Group A had the highest muscle fat and the least ash percentage than the other groups. Sarcoplasmic proteins percentages were higher in group B, while myofibrilar protein percentage was higher in group A. Non protein nitrogen was higher in group A and D. Moisture percentage was higher in group E than the other groups.

Meat Quality Attributes: Data of meat quality attribute of the experimental lambs are shown in Table 10.

Cooking loss: Cooking losses showed significant (P < 0.01) differences between the treatment groups. Meat from group C recorded the highest cooking loss (3.107%), while meat from group B had the least cooking losses.

Shear Force: Shear force, which measures muscle fibre strength, was significantly (P < 0.00 1) different among the treatment groups. Muscles obtained from group C had higher shear force (4.68 kg/cm2) indicating an increase in its toughness than the other groups. Connective tissue strength was maximum also in group C and minimum in group A.

Water Holding Capacity: Water holding capacity values of muscle studied were significantly (P < 0.01) different among the treatment groups. Group A showed superior WHC values. On the other hand group C and E showed inferior WI-IC values.

Meat Colour: Significant difference among the treatment groups was observed for hunter lightness (L) (P <0.05), redness (a) (P <0.001) and yellowness (b) (P < 0.001). Group A had the highest values for lightness while group C had the highest values for redness, where as group E had the highest values for yellowness and lowest values for lightness.

Subjective Evaluation of Meat Quality: Subjective evaluation of meat quality is represented in Table 11. There was no significant difference among the treatment groups for all evaluated eating quality attributes. Colour scores were higher for group A and D followed by group C, but group B and E had received lower colour scores. Flavour scores were higher in group B and C then for the other groups. Higher scores for tenderness were given for lambs in group A and E. Juiciness scores were highest in group A and least in group E. Generally meat from group A tended to have the highest scores for colour, tenderness and overall acceptability while group E tended to have the least scores for colour, flavour, tenderness, juiciness and overall acceptability.

Discussion:

Carcass Weight and Dressing Percentage: There were no significant differences among the treatment groups observed for slaughter weight and carcass weight (cold or warm). Also no significant differences among treatment groups were found for dressing percentage either on empty weight or live weight basis. Differences in slaughter weight and carcass weight, though were not significantly different among the treatment groups, yet decreased with the increase in the level of WMSC in the diet. Here a gain diet digestibility and utilization could be implicated.

Dressing percentage also decreased, but not significantly with the increase in WMSC level. This decrease could be attributed to the slight decrease in carcass weight and to the increase in gut fill.

The values for dressing percentages were in line with that reported by El-Khidir et al. [47], El-Khidir et al. [45], Babiker and Mohammed [20], Mansour et al. [91], El-Hassan [51], Arabi [17], Beshir [24] and Suliman [159].

El-Karim and Owen [42] reported a respective dressing percentages of 45.06 ar d 43.35 for Sudan desert sheep ecotype (Watish and Shugor) which were lower than the values reported in this study. Here, ecotype differences and ration composition might be also responsible.

Gut Fill: Although no significant differences were observed for gut fill among the treatment groups, Gut fill percentage in this study increase with WMSC level increase in the diet. The increase in crude fibre level and the decrease in diet digestibility might be the two main reasons for gut fill level increase. El-Khidir et al. [47] and Suliman [156] reported similar gut fill values, however, Mansour et al. [93], El-Khidir [45], Babiker and Mohammed [20], El-Hassan [41] and Beshir [24] gave different gut fills than those reported in this study. These variations in gut fill could be due to type of feed, ration chemical and physical composition, age, species and preslaughter conditions of the animals.

Carcass Shrinkage: No significant differences were observed among the dietary treatments for carcass shrinkage. Carcass shrinkage or moisture loss is the proportion of the carrrass moisture lost by evaporation during the cold storage period. Generally, carcass with good subcutaneous fat cover suffer less loss. In addition, refrigeration conditions and duration affect this parameter. In this study carcass fat was not significantly different among the different treatment groups. The carcass shrinkage values in the present
study were lower than those obtained by Mansour et al., [93], Beshir [24] and Suliman [199]. These differences might possibly be due to the duration, temperature, humidity of refrigeration used and amount of carcass fat.

**Eye Muscle Area:** Development in the muscle Longissimus dorsi is closely related to the development and muscling of the carcass. In this study the value of the eye muscle area of lambs fed on diet A was found to be superior to others. However, the values for eye muscle area reported by El-Shafei and Osman [41], Osman et al., [126], Suliman and El-Amin [157], Mansour et al. [93] and Mansour et al. [93] were smaller than that shown in this study.

**Non-carcass Components:** Non-carcass components were not significantly different among the treatment groups. Similar findings were obtained by El-Khidir [43], El-Hassan [41], El-Wassabi [51], Beshir [24] and Gaif [53] who showed that nutritional treatment imposed no effect on non-carcass components.

Ornamental, Mesenteric and Kidney Knob and channel fat depots were greater in group A and B than the other groups. This might be due to improved diet and fat digestibility of these studies.

**Yield of Whole-sale Carcass Cuts:** The major whole sale cuts as leg and chump, single short fore quarters, loin, best end of neck, breast and neck were expressed as percentage of cold carcass weight. The cut weights were not significantly different among the treatment groups. The whole sale cuts values reported by El-Khidir [43] and El-Hassan [41], El-Wassabi [51], Beshir [24] and Suliman [199] for Sudan desert lambs were in the line with the values reported in this study.

**Carcass Composition:** In this study the carcass muscle percentage was 63.55, 62.85, 61.90, 61.74 and 61.37 for group A, B, C, D and E respectively. Although group A had more percentage carcass muscle, the total carcass muscle was not significantly different among the treatment groups. This result was in agreement with the result reported by Mansour et al.[93], El-Wassabi [51] and Beshir [24] for desert sheep. Moreover, it was greater than those results obtained by El-Khidir et al. [43], Babiker and Mohammed [20], Mansour et al. [91], El-Hassan [41] and Suliman [199] for the same sheep breed.

Fat percentage in this study was 17.57, 17.47, 15.98, 15.14 and 15.11 for group A, B, C, D and E respectively and was not significantly different among the treatment groups. But group A and B had the highest total carcass fat percentage. The fact that the diets were iso-caloric and iso-nitrogenous, could explain lack of significant differences in carcass fat.

The values obtained here were higher than those reported by Mansour et al. [93] and El-Hassan [41], but lower than those reported by Mansour et al. [91] and Beshir [24].

Bone percentage recorded here was 23.80, 24.13, 24.19, 25.53 and 25.67 for group A, B, C, D and F respectively, which had no significant effect among the treatment groups. Group E recorded the highest total carcass bone percentage, while group A recorded the least value. This observation could be explained by the fact that animals in group A had the highest muscle and fat percentages than these in group E. total bone percentage reported in this study was greater than that reported by El-Khidir [43], Mansour et al. [93], Mansour et al. [91], El-Hassan [41], El-Wassabi [51], Beshir [24] and Suliman [199]. This variation in bone percentages might be due to mineral differences in diets and age which affected carcass composition.

**Joint Composition:** Joint composition expressed as percentage of joint weight is shown in Table (7). No significant differences among the treatment groups were observed for leg and chump, single short for quarter, loin, best end of neck, breast, neck and tail muscle, fat and bone. Generally group A in most joints tended to have greater muscle and lesser bone than the other groups. On the other side fat in all joints was greater in group A and B. The increased muscle and fat in group A might be due to its improved diet digestibility. These findings were in line with that reported by Beshir [24] for sheep fed graded levels of karkadeh seeds.

**Protein:** Meat protein percentage in this study was not significantly different among treatment groups. All groups except group E showed similar (22.75) values for this parameter. Group E showed the least value (22.58). The values for protein percentage in this study disagreed with that reported by Beshir [24] who found (21.88, 21.22 and 20.57) for lambs fed graded levels of karkadeh seeds.

**Fat:** Fat percentage here in showed significant (P < 0.01) effect among the treatment groups. Group A recorded the highest fat percentage, while group E recorded the lowest fat percentage. This might be explained by improved fat digestibility. The obtained results were in accord with those reported by El-Khidir [43], El-Hassan [41] and Beshir [24] for desert lambs.

**Moisture:** Moisture percentage was not significantly different among the treatment groups. Group E had the highest moisture percentage, while group A had the lowest percentage, which coincided with its highest fat percentage.
The values for moisture percentage reported in the present study was in close line with the results reported by El-Khidir\textsuperscript{[43]}, El-Hassan\textsuperscript{[41]}, Beshir\textsuperscript{[24]} and Suliman\textsuperscript{[159]}.

Ash: There was a linear significant (\(P < 0.01\)) relationship between ash percentage and WMSC levels in experimental diets. Thus group E had the highest ash content compared to group E which had the least percentage. This findings agreed with that reported by El-Wassabi\textsuperscript{[51]} and Suliman\textsuperscript{[159]}. But in contrast with that reported by Beshir\textsuperscript{[24]}.

Protein Fractionation: The concentrations of proteins indicated that sarcoplasmic proteins were significantly (\(P <0.001\)) higher in group A and least in group C. The values reported here in was higher than that reported by El-Khidir\textsuperscript{[43]} for desert sheep.

The myofibrillar protein concentration showed no significant difference among tested groups. However, group A recorded the higher value of myofibrillar protein percentages, while group D recorded the least values. The values obtained in this study were also higher than those reported by El-Khidir\textsuperscript{[43]}.

Non-protein nitrogen showed significant (\(P < 0.05\)) difference among the treatment groups. Higher values for this parameter were recorded by group A and D.

Meat Quality Attributes:

Water-holding Capacity: Water holding capacity in this study showed significant (\(P < 0.01\)) difference among the treatment groups. The superior water holding capacity found in the meat from A, could be explained by their high fat, sarcoplasmic and myofibrillar proteins and non-protein nitrogen content\textsuperscript{[44]}. On the other hand inferior water holding capacity value recorded in group E was attributed to its least fat percentage and increased muscle moisture. These findings were better than those reported by Beshir\textsuperscript{[24]} and Suliman\textsuperscript{[159]}.

Cooking loss: Cooking loss percentage data showed significant (\(P <0.01\)) differences among the treatment groups. Lower cooking loss was found in meat from group D, while highest cooking losses were found in group C. These differences in cooking loss could be attributed to differences in water holding capacity already mentioned. The values of cooking loss in this study were lower than those reported by El-Wassabi\textsuperscript{[51]}, Beshir\textsuperscript{[24]} and Suliman\textsuperscript{[159]}.

Shear Force and Connective Tissue Strength: Shear force and connective tissue strength were significantly (\(P < 0.001\)) and (\(P < 0.01\)) different among the treatment groups respectively. Group C had higher values of shear force and connective tissue strength than the other groups. This might possibly be due to differences in fatness as fat is known to dilute connective tissue content and increase muscle tenderness\textsuperscript{[43]}.

Meat Colour: Meat colour values revealed significant (\(P <0.05, P < 0.001\) and \(P <0.001\)) effects among the treatment for lightness, redness and yellowness respectively.

These values for Hunter colour components indicated that group C, D and E were darker in colour than group A and B. This findings accorded with myoglobin concentration in meat which decreases as the percentage of intramuscular fat increases\textsuperscript{[73]}.

Subjective Evaluation of Meat Quality: The results of all the tasted attributes i.e. colour, flavour, tenderness, juiciness and overall acceptability were not significantly different among the treatment groups. On the other hand, all attributes tended to have higher scores in group A, followed by group B. This might be associated with increased fatness in these groups (A and B) over the other groups.

Summary and Conclusions: Forty five entire male Sudan desert lambs (9-12 months of age and averaging 31.5 kg) were utilized in a growth trial to evaluate five levels (A 0%, B 25%, C 50%, D 75% and E 100%) of water melon seed cake (WMSC) in their diets. Diets were iso-caloric and iso-nitrogenous. The diets were offered ad libitum (after an adaptation period of two weeks) for 63 days. Green fodder (Medicago saliva) forage was given weekly.

Dietary treatments did not affect any carcass parameter. The proportions of whole-sale cuts were also not influenced.

Carcass composition parameters did not differ significantly among the treatment groups. Muscle and fat percentages were slightly higher in the control group. But bone percentage was higher in group E which had given higher percentage of WMSC.

The slaughter by-products showed no significant differences among dietary treatments.

Chemical composition of meat revealed that the protein content in the muscles of all treatment groups except group F had similar values. Group A had the highest (\(P <0.01\)) fat and lowest moisture for lightness, redness and yellowness respectively, indicated that group C, D and E were darker in colour than group A and B. This possibly might be due to a decrease concentration of myoglobin as an increase in intramuscular fat.

Dietary treatments showed no significant effect among the tested groups for taste panel scores of
tenderness, juiciness, flavour, colour and overall acceptability. However, meat from animals in group A was desired more than the meat from other groups.

There is a significant effect (P < 0.01 and P <0.05) among treatment groups for sacro plasmic proteins and non-protein nitrogen respectively, but there was no significant effect was observed for myofibrilar proteins. The values of these proteins were decreased with increasing dietary level of WMSC.

Meat quality attributes showed significant effect for water holding capacity (P <0.001), cooking loss (P < 0.01) and shear force (P < 0.00 1) indicated that meat of group A was of superior water- holding capacity and lower cooking losses, so it was more tender than the other groups.

The meat colour revealed significant (P < 0.05), (P <0.01) and (P < 0.00 1) effect among dietary treatments.

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