Tenderizing effects of protease extract from *Solanum dubium* (Gubbain) seed in *longissimus* muscle from Sudanese beef cattle

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I. INTRODUCTION

Sudanese beef cattle are raised in extensive rangeland production systems. Cattle are invariably exposed to environmental stressors such as high temperatures, herding and transportation on the hoof and cattle are slaughtered at relatively mature ages (≥ 4 years old). It is known that old animals produce tough meat due to less degradable connective tissue structure and less postmortem proteolysis due to insufficient endogenous proteolytic enzyme activity for postmortem tenderization [1;2]. It was suggested that the tenderness of such meat can be improved by exogenous enzymes. *Solanum dubium* (Gubbain) is an indigenous plant found in many regions of Sudan. Seeds from this plant have been used as traditional method to enhance milk coagulation to make white soft cheese because of its known proteolytic activity and the plant is non-toxic for humans [3]. Therefore, the use of extracts of *Solanum dubium* seed as tenderizer in beef from Sudanese cattle was investigated. Meat pH, color, cooking loss (CL), shear force (SF) and sensory characteristics were evaluated.

II. MATERIALS AND METHODS

Thirty Sudanese Baggara bulls representative of two age groups: 4-4.5 and 5-5.5 years old, with an average live weight of 301.67 ± 16.22 and 258 ± 4.93 kg respectively were slaughtered at the abattoir of the Animal Production Research Centre (KUKU) in Sudan. Samples of *longissimus dorsi* muscle were collected between the 9th and 12th rib of the left side of each carcass at 24 h post-slaughter. Each muscle was divided into two samples, one was injected (10% muscle weight) in different portions with fresh *Solanum dubium* seeds aqueous extract, by using an injector with a single needle and the other left as control. The muscles were incubated overnight at 4^{o}C and then samples were analyzed for pH, color, cooking loss, SF and sensory evaluation. A sensory unstructured scaling method was used to evaluate the sensorial analysis.

III. RESULTS AND DISCUSSION

Results showed that injection of meat with an aqueous extract of *S.dubium* seeds did not affect meat pH, L* values, a* values, chroma values and some sensory scores such as color, aroma and flavor (Table 1, Table 2). No significant interaction effect was detected between injection and slaughter age for meat quality.

Table 1 Instrumental color, pH, CL and SF (means ± standard deviation) as affected by injection and slaughter age

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	Injection		Slaughter age (Years)		P-value		
Item	Control	Injected	4-4.5	5-5.5	Injection	Age	Injection x Age
L* (Lightness)	42.00 ± 3.05	42.79 ± 2.21	43.31 ± 3.29	41.48 ± 2.21	0.292	**< 0.05**	0.984
a* (Redness)	14.82 ± 1.36	14.65 ± 1.68	14.07 ± 1.60	15.39 ± 1.10	0.638	**< 0.0001**	0.287
b* (Yellowness)	14.72 ± 1.30	15.56 ± 1.67	14.88 ± 1.44	15.40 ± 1.62	**< 0.05**	0.190	0.893
Chroma = $(a^{*2}+b^{*2})^{1/2}$	20.91 ± 1.60	21.40 ± 2.04	20.52 ± 1.75	21.79 ± 1.70	0.279	**< 0.01**	0.532
Hue-angle = $\tan^{-1}$ (b*/a*)	44.83 ± 2.72	46.74 ± 3.24	46.65 ± 3.42	44.91 ± 2.54	**< 0.05**	**< 0.05**	0.415
pH	5.54 ± 0.10	5.49 ± 0.13	5.50 ± 0.11	5.52 ± 0.13	0.067	0.680	0.991
Cooking loss %	18.16 ± 3.12	27.59 ± 2.70	23.78 ± 5.00	21.98 ± 6.03	**< 0.001**	**< 0.05**	0.672
Shear force (kg)	6.00 ± 1.20	2.12 ± 0.76	3.41 ± 1.93	4.71 ± 2.29	< **0.0001**	< **0.05**	0.218

Injected muscles resulted in higher b* values ($P < 0.05$), higher hue values ($P < 0.05$), higher cooking loss ($P < 0.001$) and more tender meat ($P < 0.0001$) compared to control (Table 1). Obviously, the extraneous water (aqueous extract injection) was not well bound in the muscle matrix could result in higher cooking loss. This was agreed with the study of Liu *et al*. (2011) [6] who reported that injection of meat with 10% water or 10% kiwifruit protease extract juice (meat weight basis) significantly increased the cooking loss compared to control samples. Meat from injected samples had also better ($P<0.001$) sensory scores regarding to juiciness, tenderness and overall acceptability than control samples (Table 2). The improved tenderness by *S.dubium* seeds extract injection could be attributed to highly degradation of meat proteins by proteolytic activity. As the *S.dubium* seeds protease enzyme has shown high efficiency for milk clotting and cheese making [4; 5].

Table 2 Sensorial analysis (means ± standard deviation) as affected by *S.dubium* seeds injection and slaughter age.

	Injection		Slaughter age (Years)		P-value		
Item	Control	Injected	4-4.5	5-5.5	Injection	Age	Injection x Age
Color	5.54 ± 1.10	5.32 ± 1.10	5.59 ± 1.00	5.28 ± 1.10	0.425	0.245	0.722
Aroma	5.81 ± 0.84	5.52 ± 1.08	5.89 ± 0.93	5.45 ± 0.99	0.244	0.083	0.875
Juiciness	5.00 ± 1.21	6.30 ± 1.21	5.76 ± 1.56	5.55 ± 1.16	**< 0.0001**	0.501	0.669
Flavour	5.78 ± 0.88	5.90 ± 1.16	5.98 ± 1.11	5.70 ± 0.93	0.660	0.299	0.186
Tenderness	5.04 ± 1.37	7.90 ± 1.22	6.66 ± 1.84	6.29 ± 2.03	**< 0.0001**	0.267	0.856
Overall acceptability	5.70 ± 1.38	7.39 ± 1.26	6.76 ± 1.47	6.32 ± 1.65	**< 0.0001**	0.207	0.642

Meat from younger bulls had brighter and better red color, higher CL% and more tender than older bulls. Similar findings were reported by Czyżak-Runowska *et al*. (2017) [7].

IV. CONCLUSION

Aqueous extracts of *S.dubium* seeds showed substantial improvements in both instrumental and sensorial measures of tenderness without negative effects on meat color and eating qualities. The present results suggest that aqueous extracts of *S.dubium* seeds seem to be a promising source of exogenous enzyme for meat tenderization, in addition to slaughtering of bulls at younger ages.

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