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Evaluation of Acid-Base Status and some Serum Biochemical Parameters in Male Nubian Goat Kids as Influenced by Dietary Supplementation with Molasses

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Abstract

The objective of the study was to evaluate acid-base status and some serum biochemical parameters in male Nubian goat kids as influenced by dietary supplementation with molasses. Twenty clinically healthy male Nubian goat kids (age: 4-6 months; weight 9-11kg) were used. The kids were assigned into 4 groups receiving different levels of molasses: 0% (M-0), 30% (M-30), 40% (M-40) and 45% (M-45) for a period of 5 weeks. Blood samples were collected from the jugular vein weekly and were used for the determination of blood pH, some serum electrolytes (Na^+, K^+ and Cl^-), serum total protein and albumin. The values of acid-base parameters: strong ion difference (SID_3), the concentration of total non-volatile weak acids ($A_{tot\text{-}protein}$ and $A_{tot\text{-}albumin}$) were calculated using the equations:serum-[SID_3] = [Na^+] + ([K^+] - [Cl^-], serum-[$A_{tot\text{-}protein}$]=[Protein](g/dl)×3.6 and serum-[$A_{tot\text{-}albumin}$]=[Albumin](g/dl)×7.6, respectively. A significant ($P<0.01$) increase in feed intake and body weight gain was observed in supplemented kids after 3-4 weeks. Serum- [Na^+], [K^+], [Cl^-] and total protein (TP) increased significantly ($P\leq0.05$) in response to dietary supplementation; however, only TP was affected significantly ($P\leq0.05$) by the duration of dietary supplementation with molasses. The initial mean values of blood pH, serum-[SID_3], serum-[$A_{tot\text{-}protein}$] and serum-[$A_{tot\text{-}albumin}$] were 7.3-7.4,45-54 mmol/l, 21-23 mmol/l and 24-27 mmol/l, respectively. Dietary supplementation with molasses had no significant effect on blood pH except for the group supplemented M-45. Serum- [SID_3], [$A_{tot\text{-}protein}$] and [$A_{tot\text{-}albumin}$] fluctuated during the experimental period; however, this pattern of response was not statistically significant except for serum-[SID_3] in week one. As a conclusion, molasses at a level of 30-40%up to 3 weeks improve growth performance of Nubian goat kids with no significant effect on acid-base and electrolytes status. The duration of dietary supplementation with molasses had a significant impact on acid-base status, electrolytes and serum proteins concentration.

Key words: *Acid-base status, electrolytes concentration, goats, molasses, serum proteins*

المستخلص

الهدف من هذه الدراسة هو تقييم حالة التوازن الحمضي- القاعدى وتركيز بعض القياسات البيوكيميائية في مصل دم صغار ذكور الماعز النوبي المتأثرة بإضافة المولاس كمكمل للعليقة الغذائية. تم إستخدام 20 من صغار ذكور الماعز النوبي صحية إكلينكياً (العمر: 4-6 أشهر، الوزن 9- 11 كجم). تم تقسيم صغار ذكور الماعز لأربع مجموعات تتلقى مستويات مختلفة من المولاس: 0٪ (M-0) و 30٪ (M-30) و 40٪ (M-40) و 45٪ (M-45) لمدة 5 أسابيع. تم جمع عينات الدم من الوريد الوداجي إسبوعيا وإستخدمت لتحديد الأس الهيدروجينى للدم (pH) وبعض الشوارد (Na^+ و K^+ و Cl^-) البروتين الكلي والألبومين فى مصل الدم. تم حساب قيم القياسات الحمضية- القاعدية فى مصل الدم $[SID_3]$ و $[A_{tot-protein}]$ و $[A_{tot-albumin}]$ بإستخدام المعادلات: serum-$[SID_3]=[Na^+]+[K^+]-[Cl^-]$, serum-$[A_{tot-protein}]$=[Protein] (g/dl)×3.6، serum-$[A_{tot-albumin}]$=[Albumin] (g/dl)×7.6،على التوالي.لوحظت زيادة معنوية ($P\leq0.05$) في معدل تناول العليقة ووزن الجسم المكتسب لدى صغار ذكور الماعز المتأثرة بإضافة المولاس بعد 3-4 أسابيع. إرتفعت تراكيز $[Na^+]$ و$[K^+]$ و $[Cl^-]$فى مصل الدم إرتفاعاً معنوياً ($P\leq0.05$) إستجابة لإضافة المولاس، بينما تأثرتركيزالبروتين الكلي معنوياً ($P\leq0.05$) فقط بفترة إضافة المولاس للعليقة الغذائية. كانت القيم الوسطية الأولية للأس الهيدروجينى للدم وتركيز $[SID_3]$$[A_{tot-protein}]$ و$[A_{tot-albumin}]$:7.3-7.4 ، 45-54 مليمول/ لتر و 21-23 مليمول/ لتر و 24-27 مليمول/ لتر،على التوالي. إضافة المولاس كمكمل للعليقة الغذائية لم يكن لها أي تأثير معنوي على الأس الهيدروجينى للدم بإستثناء المجموعة M-45. أظهرت تراكيز$[SID_3]$ و$[A_{tot-protein}]$ و$[A_{tot-albumin}]$ فى المصل تذبذباً خلال فترة إجراء التجربة، ومع ذلك لم تكن الإستجابة ذات دلالة إحصائية بإستثناء $[SID_3]$ في الأسبوع الأول. كخلاصة وجد أن إضافة المولاس بنسبة 30-40٪ لفترة تصل إلى 3 أسابيع قد حسن أداء النمو فى صغار ذكور الماعز النوبي مع عدم وجود تأثير كبيرعلى حالة التوازن الحمضي- القاعدي وتركيز الشوارد.أحدثت فترة إضافة المولاس كمكمل للعليقة الغذائية تأثيراً كبيراً على حالة التوازن الحمضي- القاعدي وتركيز الشوارد والبروتينات فى مصل الدم.

***كلمات مفتاحية:** حالة التوازن الحمضي-القاعدي، تركيز الشوارد، الماعز، المولاس، بروتينات المصل*

Introduction

Acid-base status in goats has been studied by earlier investigators on the basis of the traditional Henderson-Hasselbalch model (Tyler and Cassin, 1975). They reported arterial blood pH as 7.36±0.05 in neonate and adult goats. Furthermore, acid-base and electrolytes disorders have been reported in goats in association with experimentally and naturally occurring pregnancy toxaemia (Gonzalez *et al.*, 2012; Tharwat and Al-Sobayil, 2014), which was characterised by a significant decrease in blood pH, bicarbonate concentration and base excess, and a significant increase in anion gap.

Molasses is an important by-product of sugar industry. It is extensively used in livestock feeding to improve palatability and to reduce dustiness (Hill *et al.*, 2008). Previously, many investigators have conducted valuable research on feeding molasses to beef cattle (Preston and Willis, 1974), dairy cattle (Broderick and Radloff, 2004), beef heifers (Arthingtonand Pate, 2002), calves (Lesmeister and Heinrichs 2005; Assefa *et al.*, 2013), beef steers (Shellito *et al.*, 2006), sheep (Vicini*et al.*, 1987) and lambs (Moeini *et al.*,2014). Other researchers used urea-molasses or molasses-mineral blocks to improve growth and production performance in goats (Hatungimana and Ndolisha, 2015; Yatoo *et al.*, 2016).To date, few data is available with regard to feeding molasses to goats or to estimate acid-base and electrolyte status in response to dietary supplementation with molasses. Roy *et al.*, (2009) studied sub-chronic toxicity of urea-molasses mineral block in goat kids. Therefore, the study was designed to evaluate acid-base status and some serum biochemical parameters in male Nubian goat kids after dietary supplementation with different levels of molasses.

Experimental animals

Twenty clinically healthy male Nubian goat kids (age: 4-6 months; weight 9-11kg) were used. The kids were assigned to 4 groups receiving different levels of molasses: 0% (M-0), 30% (M-30), 40% (M-40) and 45% (M-45) for a period of 5 weeks.

Housing and management

The kids were housed individually in shaded corral pens made of concrete floor, zinc roof and wire net side (1.5m×1.5m×2m). Each kid was offered 0.5 g of the experimental diet daily in addition to fed fresh *Sorghum lactabiocolor* (Abu 70) as roughage. The refusal was weighed in the next day and subtracted from 0.5 g to estimate daily feed intake.

A proximate analysis of the experimental diets

The ingredients and the chemical composition of the experimental diets are shown in Table 1a.

Table 1a: **Ingredients, chemical composition and proximate analysis of the experimental diets**

Ingredients (%)	M-0	M-30	M-40	M-45
Sorghum	52	22	22	22
Wheat bran	25	15	10	7
Groundnut cake	9	18	13	11
Groundnut hull	12	13	13	13
Molasses	0	30	40	45
Urea	0	0	0	0
NaCl	1	1	1	1
Limestone	1	1	1	1
Total	100%	100%	100%	100%
Chemical composition				
DM (%)	93.2	89.8	88	88
Fat (%)	2.5	1.7	0.6	0.6
CP (%)	25.5	26.5	25	25
CF (%)	10.1	12.3	9.4	9.4
Ash (%)	6.9	9.7	3.1	3.1
NFE(%)	48	50	32	32
ME (Kcal)	1.1	0.8	0.7	0.7

DM: Dry matter, CP: Crude protein, CF: Crude fibre, NFE: Nitrogen-free extract, ME: Metabolizable energy

M-0 (0% molasses), M-30 (30% molasses), M-40(40% molasses) and M-45(45% molasses)

The chemical composition of the experimental diets was estimated on dry matter basis. A proximate analysis was performed according to the procedure described by the Association of official Agricultural Chemists (AOAC 1990). Molasses was brought from Sennar Sugar Factory (Sennar City, Sudan), and it was chosen due to its availability, being cheap and as a rich source of nutrients such as carbohydrates, minerals, and some proteins. The chemical composition of molasses is presented in Table 1b.

Table 1b: Ingredients, chemical composition of molasses taken from Sennar Sugar Factory (Sennar City, Sudan)

Ingredients	**(%)**
Organic materials	
Sucrose	32
Glucose	14
Fructose	16
Non-sugar materials	
Azotic material	10
SiO_2	0.5
KO_2	3.5
CaO	1.5
MgO	0.1
Organic materials	
P_2O_2	0.2
MnO_3	0.2
SO_3	1.6
Chloride	0.4
Ash	10.5
Water	20

Growth performance and feed conversation ratio

The initial body weights were recorded in the beginning of the experiment. Then the kids were weighed weekly using a traditional balance (Every, UK). Daily weight gain and feed conversion ratio were calculated.

Blood collection

Blood samples were collected from the jugular vein using plastic syringes (7.5 ml, Pirmvetta®, Laboratory Technique, and GmbH, Germany).The blood samples were collected weekly during molasses supplementation. Blood pH was determined directly within 10 min of sampling using a pH meter (HANNA instruments, Portugal). The blood samples were centrifuged and the serum was separated in sterile containers and frozen at -20°C for analysis.

Laboratory analysis

Serum samples were used for determination of sodium (Na^+) and potassium (K^+) using a flame photometer technique (PFP7 Jeway, EU). Serum chloride (Cl^-) total protein and albumin were determined using spectrophotometric methods using commercial kits (Spinreact, Spain). The values of electrolytes, total protein and albumin were used for the calculation of certain acid-base parameters as described by Stewart, (1983), Rehm *et al.*,(2004), Constable *et al.*,(2005) and Bachmann, (2008):

Serum-$[SID_3]$ mmol/l= $[Na^+] + [K^+]-[Cl^-]$ mmol/l (1)

Serum- $[A_{tot\text{-}protein}]$ mmol/l = [Protein] g/dl × 3.6 (2)

Serum- $[A_{tot\text{-}albumin}]$ mmol/l = [Albumin] g/dl × 7.6 (3)

Statistical analysis

Statistical analysis was performed using SPSS for Windows version 20 and Statistix8. General Linear Model (GLM), ANOVA (Levine's Test and Post Hoc Test) was used to assess the possible significant differences between the groups. The Paired samples T-test was used to estimate the significant difference in acid-base parameters at each time point after molasses supplementation. The interaction of the treatments was assessed using LSD All-pairwise comparison test. The mean difference was considered significant at $p \leq 0.05$.

Results

Table 2 shows that dietary supplementation with molasses induced a significant ($P<0.01$) increase in feed intake, daily body gain and feed conversation ratio. Highly significant ($P<0.0001$) increase in the body weight gain was observed in group M-40 compared to the other groups.The highestfinal body weight gain was observed in group M-40 ($P<0.0001$).

Table 2: **Growth performance and feed conservation ratio of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)**

	M-0	M-30	M-40	M-45	P value
Initial body weight (kg)	$10^{a}\pm0.8$	$10.3^{a}\pm0.7$	$10.6^{a}\pm0.7$	$9.6^{a}\pm0.6$	NS
Final body weight (kg)	$10.4^{a}\pm0.8$	$10.9^{b}\pm0.8$	$11.3^{b}\pm0.9$	$9.9^{c}\pm0.6$	≤0.05
Body weight gain (kg)	$0.4^{a}\pm0.2$	$0.6^{b}\pm0.2$	$0.8^{bc}\pm0.3$	$0.4^{a}\pm0.1$	≤0.05
Feed intake (g)	$969^{a}\pm281$	$1126^{b}\pm250$	$1186^{b}\pm315$	$1187^{b}\pm174$	≤0.05
Feed conservation ratio	$1.4^{a}\pm1.3$	$0.8^{b}\pm0.7$	$0.8^{b}\pm0.3$	$0.8^{b}\pm0.6$	≤0.05

Means within the same row bearing different superscripts are significantly different ($P\leq0.05$).NS: Not significant, M-0(0% molasses), M-30 (30% molasses), M-40(40% molasses) and M-45(45% molasses)

The responses of certain serum electrolytes, total protein and albumin to dietary supplementation with molasses are shown in Figs. 1, 2, 3, 4 and 5. Serum-[Na^+], [K^+], [Cl^-], total protein and albumin were affected significantly ($P \leq 0.05$) by dietary supplementation with molasses. Fig.1 indicates that the initial mean values of serum-[Na^+] were 154-159 mmol/l for all kids. A significant ($P<0.01$-0.05) decrease in serum-[Na^+] (hyponatraemia) was observed after 4 weeks of starting molasses supplementation.

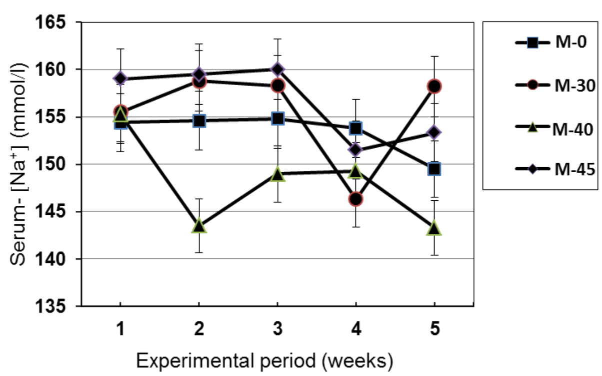

Fig 1. Serum- [Na^+] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

Fig. 2 shows that the initial mean values of serum-[K^+] were 5.2-6.3 mmol/l for all kids. A gradual significant ($P<0.01$-0.05) increase in the serum-[K^+] was observed after 4 weeks in all supplemented kids except group M-45. Thenthe serum- [K^+] decreased ($P<0.05$) after 5 weeks in groups M-30 and M-40compared to the control group.

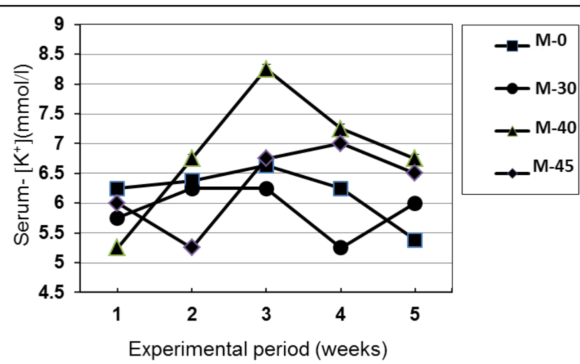

Fig 2. Serum- [K^+] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

The initial mean values of serum-[Cl^-] were 106-112 mmol/l for all kids (Fig. 3). Serum-[Cl^-] decreased significantly ($P<0.01$-0.05) in all supplemented kids except for group M-40in which the significant decrease developed between 2-5 weeks after ingestion of molasses.

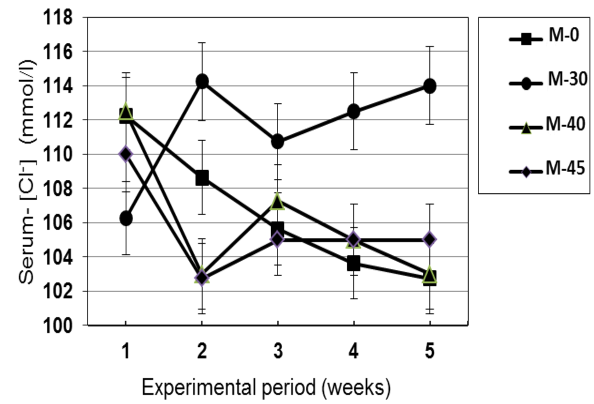

Fig 3. Serum- [Cl^-] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

The initial mean values of serum-[total protein] and [albumin] were 61-64 g/l and 34-37 g/l, respectively (Figs. 4 and 5). A gradual significant ($P<0.01$-0.05) increase in the serum-[total protein] and [albumin] was observed after 2-4 weeks in all supplemented kids.

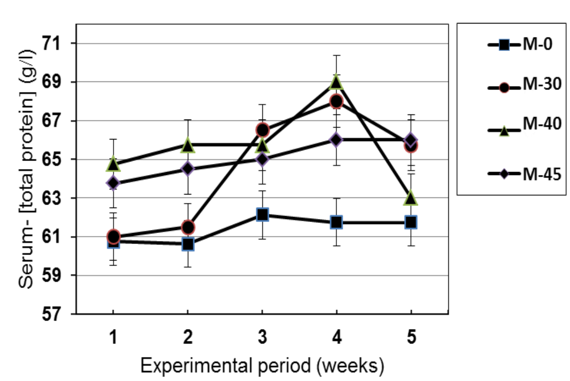

Fig 4. Serum- [total protein] (g/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

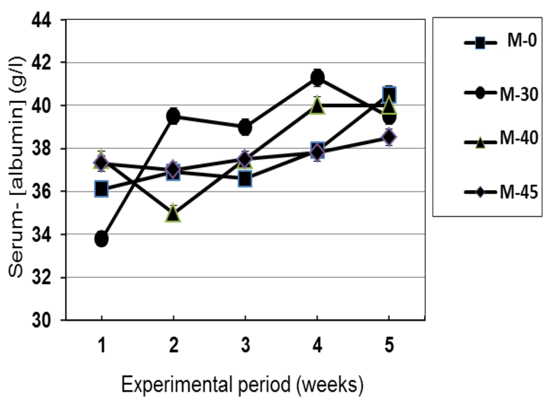

Fig 5. Serum- [albumin] (g/l) of male Nubian goat kids as influenced by dietary supplementation of molasses (n=20)

Fig.6 shows that the initial mean values of blood pH were 7.35-7.40 for all groups. The general pattern of response showed that after 2 weeks of starting supplementation with molasses, there was a sharp significant ($P<0.01$) decrease in the mean values of blood pH in all kids. After 2-5 weeks of starting molasses supplementation, the blood pH maintained at significant ($p<0.01$) lower values in groupM-45compared to the initial values and the control group (7.33-7.30).

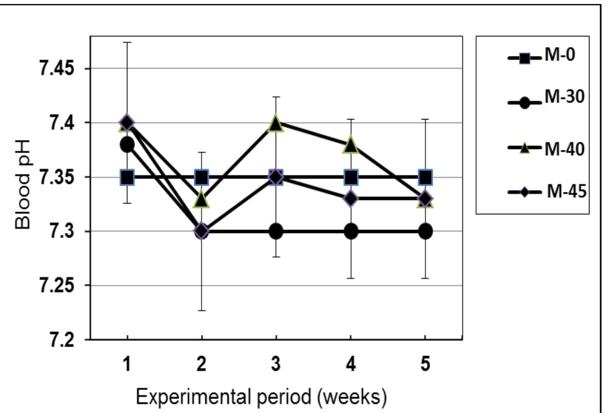

Fig 6. Blood pH of male Nubian goat kids as influenced by dietary supplementation of molasses (n=20)

The initial mean values of serum-[SID_3] were45-55 mmol/l for all kids (Fig. 7). The general pattern of response showed that the mean values of serum-[SID_3] fluctuated during the experimental period. Supplementation of molasses induced a significant increase ($P<0.01$) in serum-[SID_3] in all kids after one week compared to the initial values except for group M-30. After 2-3 weeks, the serum-[SID_3] maintained at higher values compared to the initial values. After 4-5 weeks, the serum-[SID_3] decreased; however, this pattern of response was not significant and it remained at a lower level compared to the control group.

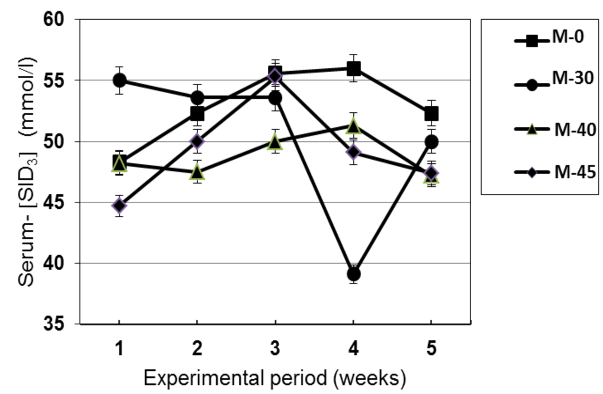

Fig 7. Serum- [SID_3] (mmol/l) of male Nubian goat kids of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

The initial values of serum- [$A_{tot\text{-}protein}$] were 22-23.5 mmol/l for all kids (Fig. 8). Supplementation with molasses caused a gradual increase ($P<0.05$) in the mean values of serum-[$A_{tot\text{-}protein}$] after 2-5weeks in all kids compared to the initial values. Then the mean values of serum-[$A_{tot\text{-}protein}$] maintained at values close to the initial values.

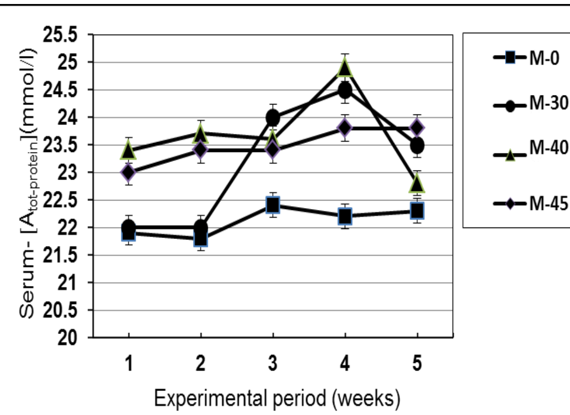

Fig 8. Serum- [$A_{tot\text{-}protein}$] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

The initial values of serum-[$A_{tot\text{-}albumin}$] were 23-

28.5 mmol/l for all kids (Fig.9). Serum-[$A_{tot-albumin}$] showed the same pattern of response to dietary supplementation with molasses as seen for serum-[$A_{tot-protein}$] except for group M-45. However, the treated kids supplemented with 30% (M-30), 40% (M-40)of molasses showed a gradual significant ($P<0.05$) increase in the mean values of [$A_{tot-albumin}$]. The treated kids supplemented with 45%of molasses (M-45) showed a significant ($P<0.01$) decrease in the mean values of [$A_{tot-albumin}$] after 2-5 weeks compared to the control group.

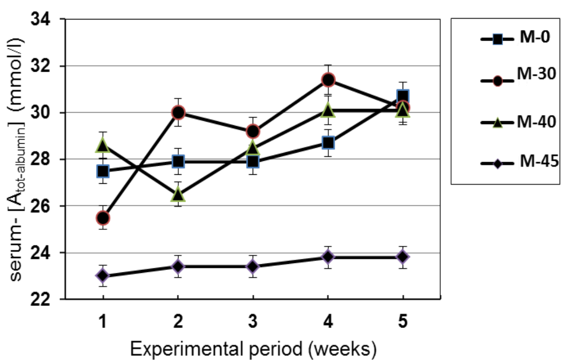

Fig 9. Serum- [$A_{tot-albumin}$] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation of molasses (n=20)

The statistical data shown in Tables 3a-d and 4a-c indicate that the interaction between the level and the duration of dietary supplementation with molasses has significant ($P\leq0.05$) effect on acid-base parameters and serum electrolytes studied. However, only the duration of dietary supplementation caused a significant ($p \leq0.05$) increase in serum-[total protein] (Table5a-b).Dietary supplementation with different levels of molasses caused a significant ($p \leq0.05$) decrease and increase in the serum-[SID_3] and [$A_{tot-protein}$], respectively. However, blood pH, serum-[$A_{tot-protein}$] and serum-[$A_{tot-albumin}$] were significantly ($p \leq0.05$) decreased and increased, respectively in response to the duration of dietary supplementation. Both the level and the duration of dietary supplementation with molasses caused a significant ($P\leq0.05$) decrease in serum electrolytes concentration except for serum-[Cl^-], which increased significantly ($P<0.001$).

Table 3a: LSD All- pairwise comparison test of blood pH of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

Groups	Number of kids	For Groups	Weeks	For weeks	Groups vs. weeks
M-0	8	7.34 ^{B}	0	7.36 ^{AB}	
M-30	4	7.33 ^{B}	1	7.38 ^{A}	
M-40	4	7.37 ^{A}	2	7.31 ^{D}	
M-45	4	7.33 ^{B}	3	7.34 ^{BC}	
			4	7.33 ^{CD}	
			5	7.33 ^{CD}	
P value		0.89		<0.05	0.31

Means within the same column bearing different superscripts are significantly different ($P\leq0.05$).
M-0(0% molasses), M-30(30% molasses), M-40(40% molasses) and M-45(45% molasses)

Table 3b: LSD All- pairwise comparison test of serum-[SID_3] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

Groups	**Number of kids**	**For Groups**	**Weeks**	**For weeks**	**Groups vs. weeks**
M-0	8	53^{A}	0	50.3^{AB}	
M-30	4	49^{B}	1	50.1^{AB}	
M-40	4	49^{B}	2	50.9^{AB}	
M-45	4	49^{B}	3	53.5^{A}	
			4	49.1^{B}	
			5	49.4^{B}	
P value		0.03		0.24	0.13

Means within the same column bearing different superscripts are significantly different ($P \leq 0.05$).
M-0(0% molasses), M-30(30% molasses), M-40(40% molasses) and M-45(45% molasses)

Table 3c: LSD All- pairwise comparison test of serum-[$A_{tot\text{-}protein}$] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

Groups	**Number of kids**	**For Groups**	**Weeks**	**For weeks**	**Groups vs. weeks**
M-0	8	22^{C}	0	22^{C}	
M-30	4	23^{AB}	1	22.5^{BC}	
M-40	4	24^{A}	2	22.7^{BC}	
M-45	4	23^{AB}	3	23.2^{AB}	
			4	24^{A}	
			5	22.9^{BC}	
P value		0.01		0.05	0.87

Means within the same column bearing different superscripts are significantly different ($P \leq 0.05$).
M-0(0% molasses), M-30(30% molasses), M-40(40% molasses) and M-45(45% molasses)

Table 3d: LSD All- pairwise comparison test of serum-[$A_{tot-albumin}$] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

Groups	Number of kids	For Groups	Weeks	For weeks	Groups vs. weeks
M-0	8	28^{A}	0	25.9^{D}	
M-30	4	28.6^{A}	1	27.3^{C}	
M-40	4	28.5^{A}	2	27.8^{BC}	
M-45	4	28.2^{A}	3	28.9^{AB}	
			4	30^{A}	
			5	29.8^{A}	
P value		0.88		<0.05	0.25

Means within the same column bearing different superscripts are significantly different (P≤0.05).
M-0(0% molasses), M-30(30% molasses), M-40(40% molasses) and M-45(45% molasses)

Table 4a: LSD All- pairwise comparison test of serum-[Na^{+}] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

Groups	Number of kids	For Groups	Weeks	For weeks	Groups vs. weeks
M-0	8	153.7^{A}	0	153.8^{AB}	
M-30	4	154.6^{A}	1	154.6^{A}	
M-40	4	148.6^{B}	2	152.8^{ABC}	
M-45	4	150.2^{B}	3	155.1^{A}	
			4	149.7^{C}	
			5	$150.^{BC}$	
P value		0.01		0.04	0.23

Means within the same column bearing different superscripts are significantly different (P≤0.05)
M-0(0% molasses), M-30(30% molasses), M-40(40% molasses) and M-45(45% molasses)

Table 4b: LSD All- pairwise comparison test of serum-[K^+] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

Groups	Number of kids	For Groups	Weeks	For weeks	Groups vs. weeks
M-0	8	6.2^{AB}	0	5.3^{D}	
M-30	4	5.7^{B}	1	5.9^{C}	
M-40	4	6.6^{A}	2	6.5^{AB}	
M-45	4	6^{B}	3	6.9^{A}	
			4	6.2^{BC}	
			5	5.9^{C}	
P value		0.01		<0.01	0.01

Means within the same column bearing different superscripts are significantly different (P≤0.05).
M-0(0% molasses), M-30(30% molasses), M-40(40% molasses) and M-45(45% molasses)

Table 4c: LSD All- pairwise comparison test of serum-[Cl^-] (mmol/l) of male Nubian goat kids as influenced by dietary supplementation with molasses (n=20)

Groups	Number of kids	For Groups	Weeks	For weeks	Groups vs. weeks
M-0	8	107^{A}	0	109^{AB}	
M-30	4	111^{B}	1	110^{A}	
M-40	4	106^{A}	2	108^{AB}	
M-45	4	107^{A}	3	109^{AB}	
			4	107^{B}	
			5	107^{B}	
P value		<0.01		0.22	0.04

Means within the same column bearing different superscripts are significantly different (P≤0.05).
M-0(0% molasses), M-30(30% molasses), M-40(40% molasses) and M-45(45% molasses)

Table 5a. LSD All- pairwise comparison test of serum-[total protein] (g/l) of male Nubian goat kids as influence by dietary supplementation with molasses (n=20)

Groups	Number of kids	For Groups	Weeks	For weeks	Groups vs. weeks
M-0	8	61.2 ^{C}	0	59 ^{A}	
M-30	4	63.6 ^{AB}	1	62.6 ^{A}	
M-40	4	65.5 ^{A}	2	62.8 ^{A}	
M-45	4	63 ^{A}	3	64.1^{AB}	
			4	66.7 ^{B}	
			5	63.5 ^{B}	
P value		0.069		0.004	0.81

Means within the same column bearing different superscripts are significantly different (P≤0.05).
M-0 (0% molasses), M-30 (30% molasses), M-40 (40% molasses) and M-45 (45% molasses)

Table 5b. LSD All- pairwise comparison test of serum-[albumin] (g/l) of male Nubian goat kids as influence by dietary supplementation with molasses (n=20)

Groups	Number of kids	For Groups	Weeks	For weeks	Groups vs. weeks
M-0	8	36.9^{A}	0	34.1^{D}	
M-30	4	37.6 ^{A}	1	35.8 ^{DC}	
M-40	4	37.5 ^{A}	2	36.6 ^{BC}	
M-45	4	37.1^{A}	3	38.1 ^{AB}	
			4	39.4 ^{A}	
			5	39.1 ^{A}	
P value		0.82		0.22	0.31

Means within the same column bearing different superscripts are significantly different (P≤0.05).
M-0(0% molasses), M-30(30% molasses), M-40(40% molasses) and M-45(45% molasses)

Discussion

In the present study, the initial mean values for serum-[SID_3] of 45-55mmol/l for goat kids were approximately similar to that reported previously for calves (Bachmann, 2008, 43-51 mmol/l; Elkhair, 2008, 44-47 mmol/l). However, the mentioned value of serum- [SID_3] was higher than those reported in the literature for other species, such as dogs (Siegling-Vlitakis *et al.,* 2007, 33-51 mmol/l), young camels (Elkhair and Hartmann, 2010, 39-49 mmol/l)and horses (Schmohl *et al.,* 2009, 39-45 mmol/l).The initial mean values for serum- [$A_{tot\text{-}protein}$] and [$A_{tot\text{-}albumin}$]of 21-23.5 mmol/l and 24-27 mmol/l, respectively for goat kids were approximately similar to that reported previously for young camels (Elkhair and Hartmann, 2010, 17-23 and 22-27 mmol/l, respectively).

After dietary supplementation with molasses, the primary response of goat kids was a significant decrease in the blood pH and serum-[SID_3] (Figs. 6and 7), which has been observed after 2 weeks of starting dietary supplementation. The secondary drop in the blood pH (acidemia) after 2 weeks of dietary supplementation; could be considered as a consequent result of a physiological adaptation to dietary changes. The significant decrease in the mean values of blood pH in all kids after 3-4 weeks of starting molasses supplementation could be attributed that molasses accelerated microbial activities, which may cause rapid drop in blood pH. The secondary drop in the blood pH could be also explained as a result of hyponatraemia and hyperchloraemia occurred after 4 weeks (Figs. 1 and 3). Many investigators have concluded that the reduction in the serum-[SID_3] can be explained by the reduced concentration of strong cations (Na^+ and K^+) and/or by the increased concentration of strong anions (Cl^-) (Stewart, 1983; Constable *et al.,* 2005; Siegling-Vlitakis *et al.,* 2007; Schmohl*et al.,* 2009; Elkhair, 2008; Elkhair *et al.,* 2009).

Serum-[$A_{tot\text{-}protein}$] and [$A_{tot\text{-}albumin}$] obtained in the present study expressed the content of weak acids in the blood (Figs. 8 and 9) showed a significant increase after 2 weeks of starting dietary supplementation.The significant increase in serum-[$A_{tot\text{-}protein}$] and [$A_{tot\text{-}albumin}$] after 2-5 week of dietary supplementation accompanied by a significant increase in serum total protein and albumin; could be explained that molasses had a positive effect on nutrient digestibility. Many investigators have concluded that the addition of molasses to animal feed increased dry matter and nutrients digestibility in lambs (Moeini*et al.,* 2014), neonatal dairy calves (Lesmeister and Heinrichs, 2005; Hill *et al.*,2008)and beef steers (Shellito *et al.*,2006). Lawler-Neville*et al.,* (2006) have reported that applying concentrated molasses caused an increase in dry matter digestibility of forage in ruminants.

Moreover, the results presented in Tables 3a-d and Tables 4a-c clearly indicated that the duration of dietary supplementation with molasses had a significant impact on acid-base parameters and electrolytes concentration. Therefore, the present data could be utilised for clinical monitoring of the influence of dietary molasses in Nubian goat kids considering the level and the duration of dietary supplementation. Although dietary supplementation with molasses at a level of 45% (group M-45) improved the growth performance of kids (Table 2); it has been observed to influence acid-base status (acidemia and decreased SID_3). Therefore, it cannot be recommended to be used in goat kids.

Conclusion

The present data indicate that SID theory of acid-base status may be applied to goats, as well as in other mammalian species. Molasses at a level of 30-45% has been successfully used to improve growth performance of Nubian goat kids. The duration of dietary supplementation with molasses had a significant impact on acid-base parameters, electrolytes concentration and serum proteins. Molasses at a level of 30 -40% up to 3 weeks had no significant effect on acid-base status. It is necessary to conduct further studies to evaluate the use of molasses in animal feed without interfering acid-base homeostasis.

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