The effect of aqueous *Aloe vera* gel extract on serum mineral compositions of Red Sokoto Bucks (Maradi)

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Abstract

This study was conducted to determine the effect of *Aloe vera* gel extract on the serum mineral compositions of Red Sokoto bucks. Blood samples were collected from 30 bucks before the commencement of administration of *Aloe vera* gel extract for serum minerals and these served as control group. The bucks were now divided into three groups A, B and C containing ten goats per group. The *Aloe vera* extract was administered orally at 1.0 ml/kg body weight daily at 3.0%, 4.0% and 5.0% to the group A, B, and C respectively for 14 days period. Five milliliters (5ml) of blood samples were collected from the jugulars vein of Red Sokoto bucks in the respective animals in the groups at 7 and 14 days, deposited into anticoagulant free plastic tubes and allowed to clot at room temperature within 3 hours of collection. Sera samples were analysed for potassium, sodium, calcium, Chloride, total protein, and albumin. Data were analysed using one way analysis of variance (ANOVA). The results showed that there were significant ($P < 0.05$) differences in the values of potassium, calcium, chloride, total protein and albumin in the pretreated control group and post-treatment groups while there were no significant difference in sodium level ($P > 0.05$) in the bucks that were administered with *Aloe vera* gel extract and control group. This indicated that oral *Aloe vera* gel administration in Red Sokoto bucks relatively caused some changes in mineral composition which may affect some physiological functions of visceral organs in these animals.

Keywords: *Aloe vera*, serum minerals, Res Sokoto.

Introduction

Aloe veras are members of the Liliaceous family and are mostly succulent with a whorl of elongated, pointed leaves (Klein and Pennys, 1988). The commonest *Aloes*, *A. barbadensis* has been referred to as *A. vera* (Coats and Ahola, 1979). *Aloes* is an erect perennial plant, originating from North Africa and the Mediterranean, with thick, very succulent, dagger shaped 30-80cm long leaves, encircling a thick, central stem. The oldest and largest leaves are at the

base, with leaves in the centre of the rosette formation being younger and smaller. Mature leaves can be 2-2.5cm thick and 6-10cm wide at the base, gradually tapering to a point at the apex. The upper leaf surface is flat or slightly dish-shaped and the lower surface rounded, with both surfaces being smooth to the touch. However, the margins of the leaf are armed with firm, spreading, triangular-shaped teeth 2-4mm long. Leaves on mature plants are a distinctive grey-green, due to the surface being

covered by a greyish bloom, although during summer they can be greener and during winter they can take on a bronze tinge. The mucilaginous gel from parenchymatous cells in the leaf pulp of *Aloe vera* is incorporated in creams, ointment, lotions and other preparations for topical use (Anshoo *et al.*, 2005).

Aloe vera is a medicinal plant that is claimed to have hypoglycemic effect with fewer side effects and less expensive without toxicity. The whole leaf of *A. vera* contains over 200 compounds including aloesin, anthraquinones (aloin and aloemodin), acemannan, saponins, sterols, amino acids and vitamins (Grindlay and Reynolds, 1986). Most of the compounds have various biological activities with potential health benefits, such as antibacterial, antiviral, wound healing, antioxidant, immunomodulatory, antineoplastic, antihypertensive and antidiabetic activities (Pandey *et al.*, 2010). The biological and toxicological effects of *A. vera* gel have been extensively studied. Gel formulations are used as functional food supplements, drugs and in cosmetics. Whole gel also has some therapeutic effects. Amongst its therapeutic properties, anti-inflammatory (Malterud *et al.*, 1993), immunostimulatory (Ramamoorthy and Tizard, 1998) and cell growth stimulatory (Rodriguez-Bigas *et al.*, 1988) activities have been reported.

Chemical constituents of *Aloe vera* have been reported to include water-soluble and fat-soluble vitamins, minerals, enzymes, polysaccharides, phenolic compounds and organic acids (Burn, 2003; Boudreau and Beland, 2006). *Aloe vera* extract have equally been demonstrated to have antioxidant abilities in humans and animals (Rajasekaran *et al.*, 2005; Kardosová, and Machová, 2006; Loots *et al.*, 2007), whilst also protecting the liver, (the major

detoxification organ) against injury (Can *et al.*, 2004; Chandan *et al.*, 2007) and improve liver enzyme functions that are associated with carcinogen metabolism (Singh *et al.*, 2003). The antioxidant and anti-inflammatory (Yagi *et al.*, 2002; Speranza *et al.*, 2005; Yagi and Takeo, 2003), anti-cancer (Lee *et al.*, 2000a; Lee *et al.*, 2000b; Heggie *et al.*, 2002; Chen *et al.*, 2004; Su *et al.*, 2006), anti-diabetic (Ayse *et al.*, 2004) and wound healing properties (Choi *et al.*, 2001) of *Aloe vera* have also been widely reported.

The activity against a variety of infectious agents has been attributed to *Aloe vera*; for instance, antibacterial (Ferro *et al.*, 2003), antiviral (Kahlon *et al.*, 1991) and anti-fungal (Kawai *et al.*, 1998). *Aloe vera* has also been reportedly used in the treatment of many disorders such as arthritis, gout, dermatitis, peptic ulcer as well as treatment of burns (Grindlay and Reynolds, 1986). The fresh gel, juice and formulated products have long been used for medical and cosmetic purposes and general health (Chithra *et al.*, 1998; Reynolds and Dweck, 1999). And have healing ability of skin burns and cutaneous injuries; prophylactic effect against radiation; leucopenia; antiulcer; inhibitor action against some bacteria and fungi with inflammation inhibiting effect. *Aloe vera* and Shea butter mixture has been used to treat mange in West African Dwarf goats (Ameen *et al.*, 2014). There is no information on effect of *Aloe vera* in serum biochemical mineral compositions in bucks therefore this study was carried out to investigate the effect of *Aloe vera* gel extracts on serum biochemical mineral compositions of Red Sokoto bucks.

Materials and Methods

Location of Study

The study was carried out at the ruminant

units of the Teaching and Research Farm of Animal Production and Health, Faculty of Agricultural Science, Ladoke Akintola University of Technology, Ogbomosho.

Source of Aloe vera leaves

The *Aloe vera* leaves were collected from the Agronomy Units of Teaching and Research Farm of Faculty of Agricultural Science, Ladoke Akintola University of Technology, Ogbomosho. They were transplanted into a bucket which contained loamy soil and were taken to the experimental site for easy access.

Experimental animals

Thirty mature Red Sokoto bucks were purchased from 'Sabo market', Ogbomosho. As determined by dentition the animals weighed between 8.5 and 9.5 kg and quarantined for six weeks during which Ivomec® for ectoparasites and endoparasites, oxytetracycline antibiotics and multivitamins were administered to the bucks. They were later vaccinated with *Peste des petits ruminants* vaccine. The animals were subsequently housed in a well-ventilated and floored pen, equipped with feeders and drinkers and were fed guinea grass (*Panicum maximum*), elephant grass and supplemental concentrates *ad-libitum*. The animals were then grouped into three, namely A, B and C made of ten animals per pen.

Preparation of Aloe vera extract

Aloe vera were washed and cut in the middle, the gel was separated by scratching with a spatula into a clean beaker, *Aloe vera* extract gel was weighed 3.0, 4.0 and 5.0g and dissolved in 100ml of distilled water to give 3%, 4% and 5% respectively.

Administration of the Aloe vera extract

The aqueous solution of *Aloe vera* gels were given to each animal orally at 1.0 ml/kg body weight using 10ml syringe for

the groups A, B and C respectively at 3%, 4% and 5%. The treatment period lasted for 14 days.

Blood sample collection

Blood samples (5ml) were collected each from the jugular vein of 30 Red Sokoto bucks and were deposited into anticoagulant free plastic tube and allowed to clot at room temperature within 3 hours of collection. The serum samples were later stored at a temperature of -20°C for biochemical studies. These were done for the animals prior to the experiment and on weekly basis.

Serum Biochemical Analysis

Serum sodium, Calcium and potassium concentrations were determined by flame photometry using Gallenkamp Flame Analyser (FGA-330) while serum chloride was determined as described by Moris and Moris, (1930). Total serum protein (TP) was determined by Biuret techniques using colourimetric method (Toro and Ackerman, 1975), while albumin was determined by using the Bromocresol green (BCG) method as described by Doumas and Biggs, (1972).

Statistical analysis

All obtained data were expressed as means with standard errors and were subjected to analysis of variance (ANOVA) according to the standard procedure Duncan multiple range test were used to compared means found to be statistically significant ($P > 0.05$).

Results

The mean values of serum minerals of bucks administered with oral *Aloe vera* gel extract at seven days post-treatment is presented Table 1. There were significant decrease ($P < 0.05$) in the K^+ , Ca^{2+} , Cl^- and

albumin values between control pre-treatment and treatment groups while total protein (TP) increased significantly ($P < 0.05$). There was no significant difference ($P > 0.05$) between the mean values of Sodium (Na^+) during pre-treatment and first week post-treatment groups although sodium values decreased. The mean values of serum minerals of bucks administered with *Aloe vera* gel extract at fourteen days post-treatment is presented in Table 2. There were significant increase ($P < 0.05$) in the K^+ , total protein (TP) and albumin values between control pre-treatment and treatment groups while the mean values of Sodium (Na^+) during pre-treatment and 14 days post-treatment groups increased without statistical

significant difference ($P > 0.05$). The Ca^{2+} and Cl^- values between control pre-treatment and treatment groups decreased significantly ($P < 0.05$). There was no significant difference ($P > 0.05$) between the mean values of Sodium (Na^+) during pre-treatment and 14 days post-treatment groups although sodium values decreased.

Discussion

Several studies have been completed on the mineral status of cattle and sheep (Dominguez and Huerta 2007; Morales *et al.*, 2007), but the establishment of serum biochemical mineral composition is important for monitoring health and physiological status of ruminants. These parameters have been used as physiological indicators of good health diseases, stress or exposure to contaminants. Metabolisms of mineral substances play a significant role in

Table 1. The mean serum mineral composition of Red Sokoto Bucks seven days after administration of aqueous oral *Aloe vera* gel with the control group.

Variable/units	Treatments (Concentration of <i>Aloe vera</i> extract)				SEM
	Control	3.0%	4.0%	5.0%	
K^+ /mmol/L	5.70 ^c	6.41 ^b	7.63 ^a	5.53 ^c	0.15
Na^+ /mmol/L	142.10	132.90	138.30	139.00	25.03
Ca^{2+} /mmol/L	2.41 ^a	2.03 ^b	2.38 ^a	2.01 ^b	0.03
Cl^- /mmol/L	106.80 ^b	108.50 ^a	105.00 ^c	103.10 ^d	1.96
TP/g/dl	3.59 ^d	8.10 ^a	6.90 ^b	5.21 ^c	0.27
AB/g/dl	2.21 ^b	1.51 ^c	3.20 ^a	2.18 ^c	0.11

^{abc}-means along the same column having the different superscript are significantly ($p < 0.05$) different.

NOTE; K=Potassium, Na=Sodium, Ca=Calcium, Cl=Chloride, TP=Total Protein, AB=Albumin

Table 2. The mean serum mineral composition of Red Sokoto Bucks 14 days after administration of aqueous oral *Aloe vera* gel with the control group

Variable/units	Treatments (Concentration of <i>Aloe vera</i> extract)				SEM
	Control	3.0%	4.0%	5.0%	
K^+ /mmol/L	5.70 ^c	5.53 ^b	5.32 ^b	6.78 ^a	0.15
Na^+ /mmol/L	142.10	139.00	137.91	163.20	25.03
Ca^{2+} /mmol/L	2.41 ^a	2.01 ^c	2.05 ^c	2.30 ^b	0.03
Cl^- /mmol/L	106.80 ^a	103.10 ^b	108.78 ^a	101.00 ^d	0.67
TP/g/dl	3.59 ^d	5.21 ^b	5.20 ^b	7.48 ^a	0.24
AB/g/dl	2.21 ^b	2.18 ^b	2.20 ^b	4.06 ^a	0.16

^{abc}-means along the same column having the different superscript are significantly ($p < 0.05$) different.

NOTE; K=Potassium, Na=Sodium, Ca=Calcium, Cl=Chloride, TP=Total Protein, AB=Albumin

the regulation of physiological functions of the puerperal period. Their concentrations in the blood circulation represent homeostatic mechanisms that are in a close relationship with the neuro-humoral regulation (Krajnicakova *et al.*, 2003). On the other hand, minerals are important as essential nutrients in the diet of animals. Physiological status might modify animal's requirements to these elements (Ahmed *et al.*, 2000). All animals require minerals for growth, reproduction, lactation and performance, which often affect the specific requirements, serve as structural or catalytic components of enzymes and regulate many physiologic systems especially pregnancy and lactation (Mbassa and Poulsen, 1991; Ahmed *et al.*, 2000; Krajnicakova *et al.*, 2003; Liesegang *et al.*, 2007).

The serum sodium concentration increased (hypernatremia) in all post-treatment groups with *Aloe vera gel extract* in 14 days although not significant may therefore, be due to the fact that Zona glomerulosa of the adrenal cortex that produce aldosterone hormone which regulates sodium in the extracellular fluid was affected by administration of *Aloe vera gel extract*. It long has been assumed that the anion, chloride, which combines with sodium to form common salt, simply follows sodium in the physiological processes that regulate body fluid and electrolyte balance. A progressive increase in serum potassium levels (hyperkalemia) was observed in some treated animals with *Aloe vera gel extract*. This may suggest none depletion of the body's potassium stores or a redistribution of potassium from the ECF into the ICF space. Also, it may be due to devoid of excessive renal loss of potassium which may result from the action of mineralocorticoid excess and as the result of altered renal tubular function in infected

animals with renal tubular acidosis or post obstructive states. Hyperkalemia is potentially more life threatening than hypokalemia. Hyperkalemia (when over 7-8 mmol/L) has a profound effect on cardiac function. There is usually marked muscle weakness and recumbency, depression, muscle tremor, bradycardia and arrhythmia and sudden cardiac arrest may occur (Radostitis *et al.*, 2007). It is becoming increasingly apparent that this may not always be true and that some of the problems ascribed to sodium retention do not occur unless chloride is present in excess as well (Kurtz *et al.*, 1987).

The hypochloremia was observed in animals treated with *Aloe vera gel extract*. Changes in chloride concentration that are not associated with a similar change in sodium concentration are usually associated with acid-base imbalances (Divers *et al.*, 1986). Chloride concentration tends to vary inversely with bicarbonate concentration. A disproportionate increase in chloride most commonly is associated with a normal to low anion gap hyperchloremic metabolic acidosis such as renal tubular acidosis and may be seen as a compensating response for a primary respiratory alkalosis (Saxton and Seldin, 1986). Disproportionate decreases in chloride characteristically are seen in a metabolic alkalosis but also may be seen as part of the compensating response for a chronic primary respiratory acidosis (Saxton and Seldin, 1986). Modest changes in hydration tend to produce roughly proportional changes in plasma sodium and chloride relative to sodium concentration. Acid-base alterations are associated with disproportionate changes in plasma chloride concentration (Saxton and Seldin, 1986). Disproportionate hypochloremia is a consistent feature of metabolic alkalosis (Rose, 1984). Chloride depletion develops

in these animals as a result of excessive loss or sequestration of fluids with high chloride content. Changes in water balance can result in modest alterations in the relative concentrations of plasma sodium and chloride. The hyperproteinaemia and hyperalbuminaemia observed may be due to the fact that *Aloe vera* contained some essential amino acids such as isoleucine, leucine, lysine, methionine, phenylalanine, threonine, valine and tryptopan and non-essential amino acids such as alkaline, arginine, asparagines, cystine, glutamic acid, glycine, histidine, proline, serine, tyrosine, glutamine and aspartic acids which may be responsible production of excessive serum protein and albumin. In conclusion the results obtained from this study indicated that oral *Aloe vera* administration in Red Sokoto bucks relatively caused some changes in mineral composition which may affect some physiological functions of visceral organs of these animals.

References

- Ahmed, M.M., Siham, K.A., and Bari, M.E.S. 2000. Micro-mineral profile in the plasma of Nubian goats as affected by physiological state. *Small Rum. Res.* 38(3): 249-254.
- Ameen, S.A., Adedokun, R.A.M., Azeez, O.M., and Akinola, S.O. 2014. Preliminary Studies on Potency of *Aloe vera* and Shea butter mixture in West African Dwarf (WAD) goats naturally infected with Sarcoptic mange, *Science Focus* 19(2):88-92.
- Anshoo, G., Singh, S., Kulkani, A.S., Pant, S.C. and Vijayaraghavan, R. 2005. Protective effect of *Aloe vera* gel against Sulphur mustard-induced systemic toxicity and skin lesions. *Indian J. Pharmacol.* 37: 103-110.
- Ayse, C., Nuriye, A., Nurten, O., Sehnaz, B., Bahriye, P. A., Refiye, Y. and Alper, O. 2004. Effect of *Aloe vera* Leaf Gel and Pulp Extracts on the Liver in Type-II Diabetic Rat Models. *Biologic. Pharmacol. Bull.* 27: 694-698.
- Boudreau, M.D. and Beland, F.A. 2006. An evaluation of the biological and toxicological properties of *Aloe Barbadensis* (Miller), *Aloe vera*. *J. Environmental Sci. Hlth C.* 24: 103-154.
- Burn, F. 2003. *Aloe vera* in medicinal plants of the World. Volume 1 Chemical constituents, in traditional and Modern Medicinal uses, 2nd edition, edited by A. Hean (Ross hamana Press Inc) Totowa, N.J). 103.
- Can, A., Akev, N., Ozsoay, N. and Bolkent, S. 2004. Effect of *Aloe vera* leaf gel pulp on the liver in type I J diabetic rats. *Biol. Pharm. Bull.* 27: 694-698.
- Chandan, B.K., Saxena, A.K., Shukla, S., Sharma, N., Gupta, D.K., Suri, K.A., Suri, J., Bhadauria, M. and Singh, B. 2007. Hepatoprotective potential of *Aloe barbadensis* Mill against carbon tetrachloride induced hepatotoxicity. *J. Ethnopharmacol.* 111:560-566.
- Chen, H.C., Hsieh, W.T., Chang, W.C. and Chung, J.G. 2004. *Aloe-emodin* induced *in vitro* G2/M arrest of cell cycle in human promyelocytic leukemia HL-60 cells. *Food Chem. Toxicol.* 42:1251-1257.
- Chithra, P., Sajithlal, G.B. and Chandrakasan, G. 1998. Influence of *Aloe vera* on the glycosaminiglycans in the matrix of healing dermal wounds in rats. *J. Ethnopharmacol.* 59: 179-186.
- Choi, S.W., Son, B.W., Son, Y.S., Park, Y.I., Lee, S.K. and Chung, M.H.

2001. The wound- healing effect of a glycoprotein fraction isolated from *Aloe vera*. *British J. Dermatol.* 145:535-45.
- Coats, B. C. and Ahola, R. 1979. *Aloe vera* the silent healer. In: Coats BC (ed.). *A Modern Study of Aloe vera*. Garland, Dallas. Pp1-288.
- Divers, T.J., Freeman, D.E., Ziemer, E.L. and Becht, J.L. 1986. Interpretation of electrolyte abnormalities in clinical disease in the horse. *Proc. Annual. Convent. Am. Assoc. Equine Practice.* 32, 69 – 80.
- Domínguez, V.I., and Huerta, M.B. 2007. Mineral concentration and interrelationship in soil forage and blood serum of sheep during two seasons in the Toluca Valley, Mexico. *Agrociencia.*42:173-183.
- Doumas, B.T and Biggs, H.G. 1972. Determination of serum albumin. In *Standard Methods of Clinical Chemistry*. GA Cooper, ed, Academic Press, Inc., New York, 7: 175.
- Ferro V.A., Bradbury F., Cameron, P., Shakir, E., Rahman, S.R. and Stimson, W.H. 2003. In vitro susceptibilities of *Shigella flexneri* and *Streptococcus pyogenes* to inner gel of *Aloe barbadensis* Miller. *Antimicrob. Agents Chemother.* 1137-1139.
- Grindlay, D. and Reynolds, T. (1986). The *Aloe vera* phenomenon: a review of the properties and modern uses of the leaf parenchyma gel. *J. Ethnopharmacol.* 16: 117-151.
- Heggie, S., Bryant, G.P., Tripcony, L., Keller, J., Rose, P., Glendenning, M. and Heath, J. A. 2002. Phase III study on the efficacy of topical *Aloe vera* gel on irradiated breast tissue, *Cancer Nurs.*, 25: 442-51.
- Kardosová, A., and Machová, E. 2006. Antioxidant activity of medicinal plant polysaccharides. *Fitoterapia.* 77:367-373.
- Kahlon, J., Kemp, M.C.X., Yawei, N., Carpenter, R.H., McAnalley, H.R., Shannon, W.M. and McDaniel, B.H. 1991. In evaluation of the synergistic antiviral effects of Acemannan in combination with Azidothymidine and acyclovir. *Mol. Biother.* 3: 214-223.
- Kawai, K., Beppu, H., Shimpo, K., Chihara, T., Yamamoto, N., Aggatsu, T., Ueda, H. and Yamada, Y. 1998. In vivo effects of *Aloe arborescens* Miller var *natalensis* Berger (Kidachi aloe) on experimental *Tinea Pedis* in guinea pig feet *Phytother. Res.* 12: 178-182.
- Klein, A.D. and Pennys, N. 1988. *Aloe vera*. *J. Amer. Acad. Dermatol.* 18: 714-20.
- Krajnicakova, M., Kovae, N.S., Kostecsky, M., Valocky, I., Maraeek, I., Sutiakova, I. and Lenhardt, L. 2003. Selected clinic-biochemical parameters in the puerperal period of goats. *Bull. Vet. Res. Institute Pulawy*, 47: 177-182.
- Kurtz, T.W., Al-Bander, H.A. and Morris, R.C. 1987. "Salt-sensitive" essential hypertension in men. *N Engl. J. Med.*, 317: 1043-1048.
- Lee, K.H., Kim, J.H., Lim, D.S. and Kim, C.H. 2000a. Anti-leukaemic and anti-mutagenic effects of di (2-ethylhexyl) phthalate isolated from *Aloe vera* Linne. *J. Pharmacol.* 52:593-598.
- Lee, K.H., Kim, J.H., Lim, D.S. and Kim, C.H. 2000b. Induction of apoptosis in human leukaemic cell lines K562, H L 6 0 and U 9 3 7 by diethylhexylphthalate isolated from *Aloe vera* Linne. *J. Pharmacol.*

- 52:1037-1041.
- Liesegang, A., Risteli, J. and Wanner, M. 2007. Bone metabolism of milk goat and sheep during second pregnancy and lactation in comparison to first lactation, *J. Anim. Physiol. Nutr.*, 91:217-225.
- Loots, T., van der Westhuizen, F.H. and Botes, L. 2007. *Aloe vera* leaf gel phytochemical content, antioxidant capacity, and possible health benefits. *J. Agric. Food Chem.* 55: 68916.
- Lowry, O.H., Rosebrough, N.J., Farr, A.L., Randall, R.J. 1951. Protein measurement with the Folin phenol reagent. *J. Biol. Chem.* 193: 265-275.
- Malterud, K.E., Farbroth, T.L. and Huse, A.E. 1993. Antioxidant and radical scavenging effects of anthraquinones and anthrones. *Pharmacol.* 47: 77-85.
- Mbassa, G.K. and Poulsen, J.S. 1991. Influence of pregnancy, lactation and environment on some clinical chemical reference values in Danish landrace dairy goat (*Capra hircus*) of different parity-I Electrolyte and enzymes. Composition of biochemical physiological B, *Comp. Biochemic*, 1009(2):413-422.
- Morales, A.E., Dominguez, V.I., Gonzales, R.M., Jaramillo, E.G., Castelan, O.O., Pescador, S.N. and Huerta, B.M. 2007. Mineral diagnosis in forage and blood serum of dairy cattle in two seasons in the Toluca valley, Mexico. *Tecnica Pecuaria Mexico*. 45 (3): 329-344.
- Morris, N. and Morris S. 1930. On the presence of a volatile organic chlorine compound in blood. *Biochem J.* 24(6):1716-1722.
- Pandey, D., Pandey, S. and Hemalatha, S. 2010. Hypolipidemic activity of aqueous extract of *Melothriamaaderaspatana*. *Pharmacol. online* 3: 76-83.
- Radostitis, O.M., Gay, C.C., Hinchcliff, K.W. and Contable, P. 2007. *Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Pigs, Sheep and Goat*, 10th ed. W.B.Saunders, Oxford.
- Rajasekaran, S., Sivagnanam, K. and Subramanian, S. 2005. Antioxidant effect of *Aloe vera* gel extract in streptozotocin induced diabetes in rats. *Pharmacol. Reports.* 57: 90-96.
- Ramamoorthy, L. and Tizard, I.R. 1998. Induction of apoptosis in a macrophage cell line RAW 264.7. *Molecular Pharmacol.*, 53:415-421.
- Reynolds, T. and Dweck, A.C. 1999. *Aloe vera* leaf gel: a review update. *J. Ethnopharmacol.* 68: pp 3-37.
- Rodriguez-Bigas M., Cruz, N.I. and Suarez, A. 1988. Comparative evaluation of *Aloe vera* in Management of burn wounds in guinea pigs *Plast. Reconstruct. Surgical*, 81:386-389.
- Rose, B. D. 1984. "Clinical Physiology of Acid-Base and Electrolyte Disorders", 2nd ed. McGraw-Hill, New York.
- Saxton, D. R. and Seldin, D. W. 1986. Clinical interpretation of laboratory values. In "Fluids and Electrolytes" (J.P.Kokko and R.L.Tannen, Eds.), pp. 3-62. Saunders, Philadelphia.
- Singh, R.P., Dhanalakshmi, S. and Rao, A.R. 2003. Chemomodulatory action of *Aloe vera* on the profiles of enzymes associated with carcinogen metabolism and antioxidant status regulation in mice. *Phytomedicine*. 7:209-219.
- Speranza, G., Morelli, C.F., Tubaro, A., Altinier, G., Duri, L. and Manitto, P. 2005. Aloeresin I, an anti-

- inflammatory 5-methylchromone from cape aloe. *Planta. Med.* **71**:79-81.
- Su, C.K., Mehta, V., Ravikumar, L., Shah, R., Pinto, H., Halpern et al. **2006**. Antioxidant properties and PC12 cell protective effects of APS1, apolysaccharide from *Aloe vera* var. *chinensis*. *Life Sci.* **78**:622-630.
- Toro, G. and Ackermann, P. G. **1975**. *Practical Clinical Chemistry*. 1st ed., Little Brown and Co, Inc., Boston, USA, 171—178.
- Yagi, A. and Takeo, S. **2003**. Anti-inflammatory constituents, aloesin and aloemannan in Aloe species and effects of tanshin on VI in *Salvia miltiorrhiza* on heart. *Yakugaku Zasshi*. **123**:517-32.
- Yagi, A., Kabash, A., Okamura, N., Haraguchi, H., Moustafa, S.M. and Khalifa, T.I. **2002**. Antioxidant, free radical scavenging and anti-inflammatory effects of aloes in derivatives in *Aloe vera*, *Plant Medicine*. **68**:957-60.