Effects of *Tamarindus indica* Fruit Pulp Powder on Blood and Serum Profile of Fluorosed Rats

Kumari Meenu¹* and J. D. Sharma¹

¹Reproductive Physiology and Environmental Toxicology Lab, Department of Zoology, Centre for Advanced Studies, University of Rajasthan, Jaipur, Rajasthan, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i43A32518

Editor(s): Dr. Jongwha Chang, University of Texas, USA.

Reviewers: Cees Th. Smit Sibinga, University of Groningen, Netherlands.
(2) Gaffar Sarwar Zaman, King Khalid University, Saudi Arabia.

Complete Peer review History: https://www.sdiarticle4.com/review-history/73646

Received 24 June 2021
Accepted 04 September 2021
Published 08 September 2021

ABSTRACT

**Aims:** Water containing a fluoride concentration of up to 1.0 mg/L is safe. It was found that the level of fluoride in groundwater is higher than surface water, which may lead to various health problems related to fluorosis. *T. indica* fruit pulp powder may help to reduce fluorosis condition in rats.

**Methods:** In the present study, healthy adult rats of Wister strain (Rattus norvegicus) weighing between 180-200gm were used for experiments. The animal was divided into five groups. Group I, control rats received only tap water (0.9ppm F). Group II rats were treated with *Tamarindus indica* fruit pulp powder (4mg/day/rat) for 60 days. Group III rats were exposed to Fluoride water (100ppm F) for 60 days. Group IV treated with fluoride water (100ppm F) along with *T. indica* fruit pulp powder (4mg/day/rat) for 60 days. whereas, group V rats were ingested fluoride water (100ppm F) for 60 days and Withdrawal from treatment for 30 days. After respective treatment animals were autopsied and biochemical parameters of blood (erythrocyte and leukocyte count, hemoglobin, hematocrits); serum (protein, glucose, cholesterol); serum enzyme activity of SGOT SGPT, Acid phosphatase, and serum fluoride and calcium level was estimated using standard techniques.

**Results:** Results revealed that total erythrocyte, hemoglobin, and hematocrit values were (*P*=.01) reduced significantly after rats were exposed to fluoride (100 ppm) water for 60 days. whereas total leucocyte count increased with fluoride (100ppm) water exposure for 60 days as compared to
control values. The serum enzyme activity of SGOT, SGPT, and alkaline phosphate elevated significantly \((P=.01)\), whereas enzyme activity of acid phosphatase diminished following fluoride water treatment to rats, as compared to control value. The level of serum fluoride enhanced significantly \((P=.01)\) in fluorotic rats as compared to the control value. However, when fluorosed rats were treated with \(T.\ indica\) for 60 days restored all altered parameters almost to control value. Withdrawal of fluoride water for 30 days revealed that there is partial recovery in all parameters studied.

**Conclusion:** Fluoride water consumption increases free radical generation, limits enzyme activity, and results in altered hematological and blood biochemistry. \(Tamarindus indica\) pulp powder was found to be beneficial in mitigating fluoride toxicity in rats.

**Keywords:** Fluoride; haematology; mitigation; \(Tamarindus indica\) blood parameter.

## 1. INTRODUCTION

Contamination of the environment by different chemicals and the resulting adverse health consequences in all living species, including humans and animals, require immediate attention across the world. For example, fluorine is a highly reactive halogen element, primarily fluorides, which bonds with nearly every cation to create stable fluoride complexes [1].

Because of its capacity to create oxidative stress, Fluoride consumption over time affects soft tissue such as the liver, kidney, brain, muscles, gastrointestinal system, and various other reproductive and endocrine organs [2-8].

the toxic effects of high doses of sodium fluoride (400mg/kg/ b.w. for 70 days) water observed in rats [9]. Fluoride water caused oxidative stress and inflammation in the liver tissues of rats. Atmaca et al. [6] also reported that fluoride water exposure to rats altered biochemical and hematological parameters [6]. Similarly, Mandal et al. observed a decline in the hematological parameters in fluorotic calves compared to control [10].

Tamarind plants have antimicrobial, anti-inflammatory, and antioxidant properties [11]. The tamarind \((Tamarindus indica L.)\) is found throughout India and has been used to treat various diseases, including pain, diabetes, diuresis problems in human and animal infections, and stress [12]. Furthermore, according to Dey et al. (2011), simultaneous usage of tamarind fruit pulp extract can lower fluoride levels in blood and bone while also increasing urine excretion, implying that tamarind fruits can help to reduce the effect of fluoride toxicity [13]. Therefore, the present study was undertaken to highlight the effects of \(T. indica\) in fluoride-exposed rats.

## 2. MATERIALS AND METHODS

### 2.1 Animals

The healthy, adult female albino rats (\(Rattus norvegicus\) of Wister strain weighing 180-200 gm were used. Animals were fed on a standard diet of rat pellets and water. Experiments were conducted under standard conditions in an animal house and were exposed for 14 hrs to daylight.

### 2.2 Experimental protocol

The animals were divided into five groups (each has 6 rats) as follows:

**Group I:** Control group of rats received only tap water contained 0.9ppmF for 60 days.

**Group II:** \(Tamarindus indica\) fruit pulp powder (4mg/day/rat) for 60 days.

**Group III:** Rats exposed to Fluoride water (100ppF) for 60 days.

**Group IV:** Rats were treated with fluoride water (100ppF) and \(T. indica\) fruit pulp powder (4mg/day/rat) for 60 days.

**Group V:** Rats were given fluoride water (100ppF) for 60 days and withdrawal from treatment for 30 days.

The animals were sacrificed after respective treatment and then autopsied, and blood was extracted through cardiac puncture. The blood was used for hematology and serum biochemistry.

### 2.3 Hematology

Total RBC count, total WBC count, hemoglobin, and hematocrit were determined using standard methods.
2.4 Serum biochemistry

Serum Fluoride, Calcium, protein, glucose, cholesterol, and serum enzyme activity of acid phosphatase, alkaline phosphatase, SGOT and SGPT, and enzymatic were carried out using standard techniques.

2.5 Statistical analysis

The data obtained were analyzed statistically using the student t test and ANOVA.

3. RESULTS AND DISCUSSION

3.1 Hematology

The results revealed that total RBC count, leukocyte count, hemoglobin, and hematocrit value of group I and group II were comparable to each other showed no harmful effects of T. indica on the blood physiology of rats. However, group III resulted in a highly significant ($P= .01$) reduction in the total erythrocyte count, hemoglobin, and hematocrit percentage as compared to the control value. These variations in erythrocyte count and haemoglobin concentrations have been linked to sodium fluorides cytotoxic effects on erythropoiesis. According to Agalakova and Gusev, the reduction in haematological indices might be due to F-induced alterations in haematopoiesis [14]. In contrast, leukocyte count increased beyond the control level revealed disease conditions in rats. Kumari and Kumar (2011) also revealed declined hemoglobin percentage and increased WBC count in fluoride toxicity of rats [15].

However, in group IV there were reversal hematological parameters (RBC, WBC, Hb, PCV) as compared to group III. Thus, it revealed the beneficial role of T. indica in maintaining hematology and the physiology of blood. Sudjaroen et al. reported the Presence of terpenoids such as geraniol and limonene in aqueous methanol extract of T. indica fruit pulp [16]. Pandey et al. explain these chemical components have free OH groups in their structure, which may interact with fluoride through hydrogen bonding and help in its removal from the body. [17,13].

In group V withdrawal treatment also showed partial improvement in blood physiology, indicating that the effects of fluoride on blood physiology are transient and reversible. However, for better recovery, the withdrawal period may be extended. Bhinda and Sharma have reported a beneficial rate of E. officinalis in fluoride toxicity of rats [18]. (Fig. 1-4)

3.2 Serum Biochemistry

In group III a highly significant ($P=.01$) decline in serum concentration of protein, glucose, and cholesterol as compared to the control group. Eraslan et. al. also observe the decreased level of serum protein, glucose, and cholesterol levels in the fluoride-treated group [19]. Fluoride is known to inhibit protein synthesis, mainly due to impairment of protein chain initiation and interfering with peptide chains on ribosomes. Fluoride has a greater affinity with hydrogen and binds with hydrogen bonds in biological molecules and hamper the various enzyme activities in physiological functions. Which in turn decreased total serum protein levels in fluoride-treated rats [20]. Prolonged exposure to F is likely to result in an inhibition of protein synthesis because F has suppressed both Na$^+$ K$^+$-activated ATPase an enzyme essential for the uptake of amino acids, and incorporation of them into protein in the tissues of rabbits [21,22]. However, a direct deleterious action of fluoride on protein metabolism can also have a role in its protein-depleting action because tissue protein has been reported to be the most sensitive and the earliest affected parameter in the fluoride-treated animal [23]. Because of these findings, it has been suggested by these investigators that depletion of protein is induced by fluoride toxicity.

Exposure of rats to NaF has been reported to decrease fructose-1,6-bisphosphate aldolase (ALD) activity, which is further responsible for defective glycolysis [24-26]. Similarly, changes in blood cholesterol levels indicated disorders of lipid metabolism. ROS and lipid peroxidation have even been considered to play an important role in the pathogenesis of chronic fluoride toxicity and oxidative stress was one of the important mechanisms of the toxic effects of fluoride [27].

This diminished protein, glucose, and cholesterol levels were increased in group IV. The withdrawal of fluoride source in group V resulted in an elevation in serum protein, glucose, and cholesterol compared to fluoride-treated rats. The results were obtained in group IV, denoting ameliorative efficacy of T. indica in rats. Tamarind seed coat extract (TSCE) polyphenols may have prevented the F-induced alterations by binding with F, therefore decreasing the harmful effects of Fluoride [28]. (Fig. 5-7).
The enzymatic activity of serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), acid phosphatase, and alkaline phosphatase of control group I, and *T. indica* (4mg/day/rat) treated rats for 60 days in group II revealed a non-significant change in all the parameters studied showing no toxicity of *T. indica*. In contrast, group III rats treated with fluoride (100ppmF) water for 60 days showed significant (*P*=.01) elevation in all enzyme activity studied except acid phosphatase enzyme activity, wherein it declined significantly (*P*=.01) as compared to the control value. Chinoy et al. also found an elevation in serum transaminase activities which may be correlated with hepatic cellular alterations and liver damage. Acid phosphatase and alkaline phosphatase are the marker enzymes for tissue function. Any alteration in the activity of these enzymes is indicative of tissue damage [29]. Bhinda and Sharma also observed a decrease in serum acid phosphatase and elevated alkaline phosphatase enzyme activity in fluorosed rats [30]. The toxic effect of a high dose of fluoride in rats, causing oxidative stress and inflammation in hepatic tissue [9]. (Fig. 8-11).

However, group IV showed improvement in all altered enzymatic activity (SGOT, SGPT, ACP, ALP) in comparison to fluoride group III. Better results were obtained with *T. indica*, showing amelioration of fluoride toxicity with *T. indica*. The presence of significant calcium concentration in the dried pulp of tamarind may explain its beneficial effect on alkaline phosphatase activity [31,32]. Yadav N *et al.*, (2016) discovered that tamarind diet modification not only reduced fluoride toxicity but also improved serum biochemistry recovery in mice [33].

Serum fluoride and calcium concentration of group I and in group II were nearly comparable to each other, revealed no toxicity of *T. indica*. Group III showed increased serum fluoride concentration and a decline in serum calcium level in rats in comparison to group I. Serum fluoride concentration is recognized as a good indicator of fluoride exposure [34]. According to Whitford,1990 the majority of the ingested fluoride is absorbed from the stomach and small intestine into the bloodstream [35]. Perera T *et al.*, (2018) observed the elevated serum fluoride levels in the fluoride-treated group [36]. Chronic NaF poisoning causes hypocalcemia in rats, indicating that long-term F poisoning impairs the calcium homeostatic system. Inadequate food intake has also been proposed as a contributing cause to hypocalcemia in rats exposed to F on a long-term basis [37].
Fig. 2. Effect of the Test substance on Leucocyte count
Values are mean ± S.E.; * = P ≤ 0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)

Fig. 3. Effect of the Test substance on Haemoglobin
Values are mean ± S.E.; * = P ≤ 0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)

Fig. 4. Effect of the Test substance on Haematocrit
Values are mean ± S.E.; * = P ≤ 0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)
Fig. 5. Effect of the Test substance on Serum Protein
Values are mean ± S.E.; * = P<0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)

Fig. 6. Effect of the Test substance on Serum Glucose
Values are mean ± S.E.; * = P<0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)

Fig. 7. Effect of the Test substance on serum cholesterol
Values are mean ± S.E.; * = P<0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)
**Fig. 8.** Effect of the Test substance on Serum SGOT
Values are mean ± S.E.; * = P < 0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)

**Fig. 9.** Effect of the Test substance on Serum SGPT
Values are mean ± S.E.; * = P < 0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)

**Fig. 10.** Effect of the Test substance on Serum Acid Phosphatase
Values are mean ± S.E.; * = P < 0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)
Fig. 11. Effect of the Test substance on Serum Alkaline Phosphatase
Values are mean ± S.E.; * = P<0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)

Fig. 12. Effect of the Test substance on Serum Fluoride
Values are mean ± S.E.; * = P<0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)

Fig. 13. Effect of the Test substance on Serum Calcium
Values are mean ± S.E.; * = P<0.01, n=6. Group I compared to Group II and Group III, Group III compared to Group IV and V. (one-way ANOVA followed by Tukeys multiple comparison test)
However, group IV revealed a decline in elevated serum fluoride level and an improve reduced level of serum calcium, indicating ameliorating effects of *T. indica* in fluoride toxicity. Increased Calcium levels in rats played a beneficial role in lowering serum fluoride concentration in fluorotic rats. The administration of dried pulp of tamarind fruits may have interfered with fluoride absorption from the gut, resulting in lower serum fluoride concentrations. The tannin and high fiber content in dried pulp may be responsible for tamarind beneficial effect [31,32]. Furthermore, the dried pulp of the tamarind fruit contains significant levels of calcium, copper, and other minerals, amino acids, and vitamins [31,38], which may play a synergistic role in fluoride elimination from the body or have other significant benefits. The positive impact of tamarind may be attributed to decreased absorption or an increase in fluoride excretion from the body. Khandare et al. discovered an increase in fluoride excretion in dogs fed tamarind fruit pulp paste orally along with fluoride [39]. In group, V caused partial recovery in both parameters studied. (Fig. 12,13).

4. CONCLUSION

The high dose of sodium fluoride to rats for 60 days exerted adverse effects on blood and serum indices. However, *T. indica* treatment to fluorosed rats reduced adverse effects of fluoride, revealing ameliorative efficacy of *T. indica* in rats. The effects brought by fluoride water to rats has transient and reversible. Fluoride has a considerable negative influence on serum indices in rats. However, the ameliorative effects of *Tamarindus indica* on treated rats reduce the fluoride-induced toxicity. As a result, the current study shows that *T. indica* could be used as a food supplement to reduce fluoride toxicity.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. WHO Environmental Health Criteria 227. World Health Organization, Geneva, Switzerland; 2002.
2. Guo XY, Sun GF, Sun YC. Oxidative stress from fluoride-induced hepatotoxicity in rats. Fluoride. 2003;36(1):25–29.
3. Argüelles S, García S, Maldonado M, Machado A, Ayala A. Do the serum oxidative stress biomarkers provide a reasonable index of the general oxidative stress status? Biochim. Biophys. Acta. 2004;1674 (3):251–259.
4. Inkielewicz-Stepniak I, Czarnowski W. Oxidative stress parameters in rats exposed to fluoride and caffeine. Food Chem. Toxicol. 2010;48 (6):1607–1611.
5. Nabavi SM, Sureda A, Nabavi SF, Latifi AM, Moghadam AH, Heflin C. Neuroprotective effects of silymarin on sodium fluoride-induced oxidative stress. J. Fluorine Chem. 2012;142:79–82.
6. Atmaca N, Ebru YJ, Güner BJRK, Bilmen FS. Effect of Resveratrol on Hematological and Biochemical Alterations in Rats Exposed to Fluoride. BioMed Res Int. 2014;1-5.
7. Sarkar C, Pal S, Das N, Dinda B. Ameliorative effects of oleanolic acid on fluoride-induced metabolic and oxidative dysfunctions in rat brain: experimental and biochemical studies. Food Chem. Toxicol. 2014;66:224–236.
8. Qin SL, Deng J, Lou DD, Yu WF, Pei J, Guan ZZ. The decreased expression of mitofusin-1 and increased fission-1 together with alterations in mitochondrial morphology in the kidney of rats with chronic fluorosis may involve elevated oxidative stress. J. Trace Elem. Med. Biol. 2015;29: 263–268.
9. Antal D, Samir D. Study of fluoride-induced hematological alterations and liver oxidative stress in rats. World journal of pharmacy and pharmaceutical sciences. 2017;6(5):211-221.
10. Mandal KD, Das MR, Pati M, Pati PD, Gupta AR, Patra RC et al. Effect of Moringa oleifera on hematological parameters of calves reared in industrial fluorotic area. Vet World. 2015; 8(11):1364-9.
11. Bhadoriya SS, Ganeshpurkar A, Narwaria J, Rai G, Jain AP. Tamarindus indica:
Extent of explored potential Pharmacognosy review 201:5(9)73.
12. Nadkarni AK., Indian Materia medica. Popular Prakashan, Bombay. 1982; Vol-1: 1191–1193.
13. Dey S, Swarup D, Saxena A, Dan A. In vivo efficacy of tamarind (Tamarindus indica) fruit extract on experimental fluoride exposure in rats. Research in Veterinary Science. 2011;91(3): 422-425.
14. Agalakova NI, Gusev GP. Excessive fluoride consumption leads to accelerated death of erythrocytes and anemia in rats. Biological trace element research. 2013;153(1):340-9.
15. Kumari, Sapna, Arbind Kumar. Fluoride toxicity enhances phagocytic activity of macrophages in spleen of rats. Asian J Exp Biol Sci. 2011;2(2):283-7.
16. Sudjaroen Y, Haubner R, Würtele G, Hull WE, Erben G, Spiegelhalder B, Changbmunrgu S, Bartsch H, Owen RW. Isolation and structure elucidation of phenolic antioxidants from Tamarind (Tamarindus indica L.) seeds and pericarp. Food and Chemical Toxicology. 2005; 43(11):1673-82.
17. Pandey VN, Malhotra, SC, Sharma DP. Pharmacological Investigations of Certain Medicinal plants and Compound Formulation used in Ayurveda and Siddha. Central Council for Research in Ayurveda and Siddha, New Delhi, India. 1996;20.
18. Shalini B, Sharma JD. Beneficial effects of Emblica officinalis on fluoride-induced toxicity on brain biochemical indexes and learning-memory in rats. Toxicology International. 2015;22(1): 35.
19. Eraslan G, Kanbur M, Siilci S. Evaluation of propolis effects on some biochemical parameters in rats treated with sodium fluoride. Pesticide Biochemistry and Physiology. 2007;88(3):273-83.
20. Sharma R, Tsuchiya M, Bartlett JD. Fluoride induces endoplasmic reticulum stress and inhibits protein synthesis and secretion. Environmental health perspectives. 2008;116(9):1142-6.
21. Opit LJ, Potter H, Charnock JS. The effect of anions on (Na-K)- activated ATPase. Biochem. Biophys. Acta 1966;120:159-64.
22. Hoertz W, Mc Carty KS. Inhibition of protein synthesis in a rabbit reticulocyte lysate system. Biochem. Biophys. Acta 1971;228:526-30.
23. Quieq D, Laghaie B, Gholipour A, Solimani N, Hassenzadeh S. Effects of sodium fluoride on total serum protein levels and transaminase activity in rats. Biomedicine & pharmacotherapy. 2002;56(4):169-72.
24. Stawierska-Pięta B, Zebracka M, Grzegorzak N, Helis A, Zalejska-Fiolka J, Birkner E, Bielec B. Influence of vitamin E on liver morphology and activity of carbohydrate enzymes of rats exposed to sodium fluoride. Fluoride. 2013;46(3):142-8.
25. Bańkowski E, Biochemistry. 2nd ed. Wroclaw: Elsevier Urban & Partner; 2009. [in Polish].
26. Birkner E, Grucka-Mamczar E, Stawierska-Pięta B, Kasperek S, Kasperczyk A, Liver aldolase and lactate dehydrogenase activity in rats with fluoride hyperglycaemia. Ann Acad Med Siles 2002;50:51-7.11. [in Polish].
27. Reddy GB, Khandare AL, Reddy PY, Rao GS, Balakrishna N, Srivalli I. Antioxidant defense system and lipid peroxidation in patients with skeletal fluorosis and in fluoride-intoxicated rabbits. Toxicological Sciences. 2003;72(2):363-8.
28. Ameeramija J, Ragahunath A, Perumal E. Tamarind seed coat extract restores fluoride-induced hematological and biochemical alterations in rats. Environmental Science and Pollution Research. 2018;25(26):26157-66.
29. Chinoy NJ, Memon MR. Beneficial effects of some vitamins and calcium on fluoride and aluminium toxicity on gastrocnemius muscle and liver of male mice. Fluoride. 2001;34(1):21-33.
30. Sharma JD, Bhinda S, Sharma PK, Kumari M, Borial W. Therapeutic efficacy of medicinal plants to mitigate fluorosis. Journal of Global Biosciences. 2014;3(5):802-7.
31. Ishola MM, Agbaji EB, Agbaji AS. A chemical study of Tamarindus indica (Tsamiya) fruits grown in Nigeria. Journal of the Science of Food and Agriculture. 1990;51(1):141-3.
32. El-Siddig, K, Gunasena HPM, Prasad BA, Pushpakumara DKNG, Ramana KVR, Vijayanand P, Williams JT. Tamarind-Tamarindus indica L. Fruits for the future. 1. Southhampton Centre for Underutilized Crops, Southampton, UK. 2006;188.
33. Yadav N, Sharma S, Sharma KP, Pandey A, Pareek P, Sharma S. Protective role of diet supplements Spirulina and Tamarind fruit pulp on kidney in sodium fluoride toxicity in rats. JPRI. 2000;51921.
exposed Swiss albino mice: Histological and biochemical indices.

34. Xiang QYCL, Wang CS, Liang YX, Liao QL, Fan DF, et al. Serum fluoride and skeletal fluorosis in two villages in Jiangsu Province. China Fluoride. 2005;38(3):178–84.

35. Whitford GM. The physiological and toxicological characteristics of fluoride. Journal of Dental Research. 1990;69:539-49.

36. Pereira HA, Leite Ade L, Charone S, Lobo JG, Cestari TM, Peres-Buzalaf C, Buzalaf MA. Proteomic analysis of liver in rats chronically exposed to fluoride. PLoS One. 2013;8(9):e75343.

37. Ekambaram P, Paul V. Calcium preventing locomotor behavioral and dental toxicities of fluoride by decreasing serum fluoride level in rats. Environmental Toxicology and Pharmacology. 2001; 9(4):141-6.

38. Almeida MM, De Sousa PH, Fonseca ML, Magalhães CE, Lopes MD, de Lemos TL. Evaluation of macro and micro-mineral content in tropical fruits cultivated in the northeast of Brazil. Ciência e Tecnologia de Alimentos. 2009;29(3):581-6.

39. Khandare AL, Kumar PU, Lakshmaiah N. Beneficial effect of tamarind ingestion on fluoride toxicity in dogs. Fluoride. 2000; 33(1):33-8.