INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-4, Issue-3, July-Sept-2014
ISSN 2231-4490
Coden : IJPAES www.ijpaes.com
Received: 1st April-2014 Revised: 10th May-2014 Accepted: 13th May-2014
Research article

COMPARATIVE EFFECTS OF RED PALM OIL AND REFINED PALM OIL AGAINST ZINC PHOSPHIDE (Zn_3P_2) TOXICITY ON MICE (*Mus musculus*)

H.Ouattara*, P. Kouamé**,A. Méité***and S. Kati-coulibaly***

* Ufr Biologie. Université Péléforo Gon Coulibaly de Korhogo, Côte d'Ivoire
** Institut Nationale de Santé Publique, Côte d'Ivoire
***Ufr Biosciences. Université Félix HOUPHOUËT-BOIGNY- Abidjan, Côte d'Ivoire
*Correspondence address, email: ouattarahowele@gmail.com

ABSTRACT: This work was undertaken in order to evaluate palm oil protective effects components (red palm oil and refined palm oil) against toxicity due to zinc phosphide (Zn_3P_2). 90 *Swiss albino* mice weighing between 18-24 g, teams up in six with 15 groups were used for research for four weeks (28 days). Adult mice group (n=6) were administered rodenticide zinc phosphide ranking from 0.4%; 0.2%; 0.1% and 0% in diet containing grilled maize powder + fish powder + red palm oil or refined palm oil or distilled water. Control groups (T1; T2; T3) received *ad libitum* red palm oil or refined palm oil or distilled water in the diet for four weeks but were not exposed to the toxic Zn_3P_2. Six groups of mice (L14; L15; L24; L25; L34; L35) were fed *ad libitum* with a diet containing a percentage of zinc phosphide (0.4%; 0.2%; 0.1 %) the day after the four weeks. Nine groups of mice (L11; L12; L13; L21; L22; L23; L31; L32; L33) received a diet (one day) containing a percentage (0.4; 0.2; 0.1 %) of zinc phosphide. Zinc phosphide caused 100% mortality in each variation of the experiments at 0.4% and 0.2% in diet. There was no significant difference ($p > 0.05$) of mortality observed at 0.1% in diet containing red palm oil or refined palm oil. Our result suggested that red palm oil and refined palm oil are not capable of protecting against toxicity caused by zinc phosphide.

Key words: Zinc phosphide, Toxicity, Protective effects, Red palm oil, Refined palm oil

INTRODUCTION

Intoxication is a group of trouble in the organism due to consumption of extraneous substances. The product could be taken intentionally in order to make a willful murder or an accidental one [1]. Substances which can provoke intoxications are usually either chemical products like pesticides, insecticides, rodenticides or industrials products like arsenic, lead, sulphur and zinc with his chemical by-products [5, 6]. Intoxication can also be due to an excess of drug consumption or toxic plant consumption like *Atractylis gummefera*, *Blighia sapida*, *Thevetia peruviana*, *Cerbera manghas* [5]. Therapeutics which are used when there is intoxication are either specific or unspecific. The high cost of these treatments and the distance between the African targeted-population and hospital complex campell African population to use traditional medicine. Then, in an emergency, populations utilize these available methods which do not cost a lot. Among these methods, palm oil takes up an important place. When a person consumes a toxic substance, he is recommended to drink red palm oil. This recommendation does not get before any scientific suspicions.The aim of this study was to evaluate and compare red palm oil and refined palm oil protective effects against the toxicity of zinc phosphide (Zn_3P_2). Zinc phosphide is a commonly used rodenticide in Côte d'Ivoire. It is one of the exceedingly toxic substances found among sold products [4]. There is a high-risk to be intoxicate by Zn_3P_2: when exposed to moisture, or gastric juice hydrochloride, it liberates highly lethal phosphine gaz (PH3), producing various metabolic and non-metabolic toxic effects [3, 8, 9, 12, 14]. Mortality due to PH3 is very high (37-100%) [3]. The clinical and pathological features are: gastrointestinal system, nausea, vomiting, diarrhea, retrosternal pain [10, 11, 12]. The poisoning may also result in anaemia and leucopenia due to deficiency in copper. Then it provokes the decrease of haemoglobin, reticulocyt, heamatochrit and globular index [10, 11, 12].

This work was performed to compare the effects of red palm oil to that of refined oil against Zn_3P_2 intoxication.

MATERIALS AND METHODS

Plant materials

Red palm oil that has not been refined and refined palm oil was brought in a supermarket in Abidjan, South of Côte d'Ivoire.

Extraction

Red palm oil was extracted using a mechanical press. After extraction it was filtered and put in bottle. Refined palm oil was extracted technologically by the society call Unilever Côte d'Ivoire.

Experimental animal

90 albino mice weighing (18-24 g) were used. They were obtained from the animal house, Institute Pasteur of Côte d'Ivoire (IPCI). The animals were grouped and housed in polyacrylic cages (28×23×10cm) and maintained under standard laboratory conditions (temperature 25±2°C) with dark and light cycle (12h/12h). The mice were acclimatized to laboratory condition for 10 days before the commencement of the experiment. At this time, they were access to diet and water *ad libitum*.

Zinc phosphide (Zn_3P_2).

Zn_3P_2 was brought in a shop. It is imported from China.

Food constitution

An attractive food was constituted with a mixing of culin to braise maize powder + Fish powder + oil in equal proportion [10].

Preliminary test

20 Swiss albino mice received individually 5 g of this food for diet during an hour. After an hour of alimentation the rest was weighed and then the mean quantity of food that could be consumed by an animal was determined.

Food composition in the real experimentation

The first diet (MFW) was constituted with a mixing of culin to braise maize powder + fish powder + distilled water. The different components of this food were used in equal quantity.

The second diet (MFR) was constituted with a mixing of culin to braise maize powder + fish powder + red palm oil. All the components of this food were used in equal quantity.

The fird diet (MFr) was constituted with a mixing of culin to braise maize powder + fish powder + refined palm oil. All the components of this food were used in equal quantity.

Real experimentation

90 Swiss albino mice (18-24 g) were used in these experiments. The Swiss albino mice were divided into 15 groups of six animals.

Control group

Control group T1 received ad libitum during four weeks the diet MFR;
Control group T2 received ad libitum during four weeks the diet MFr;
Control group T3 received ad libitum during four weeks the diet MFW.

Experimentation n°1

- Each mouse of the control group (L11) in this experiment received 1 g (according to preliminary test, 1 g of food can be consumed by each animal) of diet MFWin which rodenticide zinc phosphide in a proportion of 0.4% was added ;
- Each mouse of the control group (L12) in this experiment received 1 g of diet MFR, which contained rodenticide zinc phosphide in a proportion of 0.4% ;
- Each mouse of the control group (L13) in this experiment received 1 g of diet MFr, which contained rodenticide zinc phosphide in a proportion of 0.4% ;
- Each mouse of the group (L14) was fed *ad libitum* with the food MFR for four weeks. The following day after the last day of the four weeks, each mouse received 1 g of the food MFR, containing rodenticide zinc phosphide in a proportion of 0.4% ;
- Each mouse of the group (L15) was fed *ad libitum* with the food MFr for four weeks. The following day after the last day of the four weeks, each mouse received 1 g of the food MFr, containing rodenticide zinc phosphide in a proportion of 0.4%.

Experimentation n°2

- Each mouse of the control group (L21) in this experiment received 1 g (according to preliminary test, 1 g of food can be consumed by each animal) of diet MFW in which rodenticide zinc phosphide in a proportion of 0.2% was added

- Each mouse of the control group (L22) in this experiment received 1 g of diet MFR, which contained rodenticide zinc phosphide in a proportion of 0.2% ;
- Each mouse of the control group (L23) in this experiment received 1 g of diet MFr, which contained rodenticide zinc phosphide in a proportion of 0.2% ;
- Each mouse of the group (L24) was fed *ad libitum* with the food MFR for four weeks. The following day after the last day of the four weeks, each mouse received 1 g of the food MFR, containing rodenticide zinc phosphide in a proportion of 0.2% ;
- Each mouse of the group (L25) was fed *ad libitum* with the food MFr for four weeks. The following day after the last day of the four weeks, each mouse received 1 g of the food MFr, containing rodenticide zinc phosphide in a proportion of 0.2%.

Experimentation n°3

- Each mouse of the control group (L31) in this experiment received 1 g (according to preliminary test, 1 g of food can be consumed by each animal) of diet MFW in which rodenticide zinc phosphide in a proportion of 0.1 % was added ;
- Each mouse of the control group (L32) in this experiment received 1 g of diet MFR, which contained rodenticide zinc phosphide in a proportion of 0.1 % ;
- Each mouse of the control group (L33) in this experiment received 1 g of diet MFr, which contained rodenticide zinc phosphide in a proportion of 0.1 % ;
- Each mouse of the group (L34) was fed *ad libitum* with the food MFR for four weeks. The following day after the last day of the four weeks, each mouse received 1 g of the food MFR, containing rodenticide zinc phosphide in a proportion of 0.1 % ;
- Each mouse of the group (L35) was fed *ad libitum* with the food MFr for four weeks. The following day after the last day of the four weeks, each mouse received 1 g of the food MFr, containing rodenticide zinc phosphide in a proportion of 0.1 %.

Mortality

Total content of mice death in each group was carried out.

Hematological parameters

Hematological analysis of blood sample of mice still alive was performed using an automatic hematological analyzer (COULTER, SEAC; Germany). Hematological parameters including hemoglobin content, total count of red blood cells (RBC) and white blood cells (WBC), differential count of leukocytes such as neutrophil (%), lymphocyte (%), monocyte (%), hematocrit (Hct), mean cell volume (MCV), mean corpuscular hemoglobin concentration (MCHC) and platelet count were measured in blood sample of mice still alive at the end of the experiments.

Statistical analysis

The experimental results were expressed as the MEAN±S.E.M. Percentage of death in group of mice was compared using G-test « Log likelihood ratio». (logiciel R. version 2.0.1 windows).Student's t-test and analysis of variance were used to analyze the other data.

P value of 0.05 was considered as statically significant.

RESULTS

Preliminary test

Preliminary test permitted to determine the mean quantity of food (1±0.08) that a mouse can consume during an hour.

Variation of mice death after consumption of food containing 0.4 % zinc phosphide

All the results obtained in this experiment are shown in table 1. We obtained 100% of mortality in each group when the proportion of Zn_3P_2 in diet is 0.4%.

Variation of mice death after consumption of food containing 0.2 % zinc phosphide

Mortality was again 100% in each group of this experiment when the proportion of Zn_3P_2 in diet is 0.2%. The results obtain in this experiment are shown in Table-2.

Variation of mice death after consumption of food containing 0.1 % zinc phosphide

In this experiment, some animals survived in each group (table 3).But there was no significant variation (p 0.05) of mortality between animals which consumed palm oil (table 4).

There was no significant variation (p 0.05) of hematological parameters between control groups Témoin1 vsTémoin2 showed in table 5, Témoin1 vsTémoin3 showed in table 6, Témoin2 vsTémoin3 showed in table 7. Zinc phosphide induced a high mortality (p 0.05) of mice in experiments group L32, L33, L34 and L35 than that observed in the control group L31 (figure 1).Mortality in groups L33 and L34 was 83.33% when that observed in groups L32 and L35 was 66.67%. That of the control group was 50%.These results are shown in figure 1.

But there was a decrease ($p < 0.05$) of total count of Red blood cell, Hemoglobin content and Hematocrit in the blood sample of mice still alive in group L 31 compare to that observed in blood sample of control group T1. These results are shown in table 8.

Table 1. Variation of mice death after consumption of food containing 0.4% of zinc phosphide

	L11	L12	L13	L14	L15
Number of mice	6	6	6	6	6
Percentage of Zn_3P_2	0.4	0.4	0.4	0.4	0.4
Percentage red palm oil or refined palm oil or distilled water in food	32	32	32	32	32
Mortality	6	6	6	6	6

Table 2. Variation of mice death after consumption of food containing 0.2% of zinc phosphide

	L21	L22	L23	L24	L25
Number of mice	6	6	6	6	6
Percentage of Zn_3P_2	0.2	0.2	0.2	0.2	0.2
Percentage red palm oil or refined palm oil or distilled water in food	32	32	32	32	32
Mortality	6	6	6	6	6

Table 3. Variation of mice death after consumption of food containing 0.1% of zinc phosphide

	L31	L32	L33	L34	L35
Number of mice	6	6	6	6	6
Percentage of Zn_3P_2	0.1	0.1	0.1	0.1	0.1
Percentage red palm oil or refined palm oil or distilled water in food	32	32	32	32	32
Mortality	3	4	5	5	4

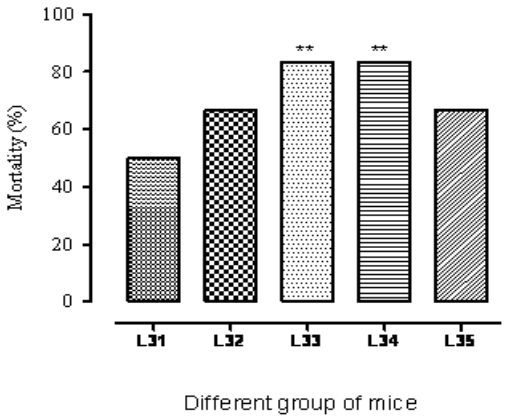

Figure 1: Comparison of mortality proportion between experiments group and control group (L31).

P 0.05: level statistically significant (**): very high probability level

Table-4: Comparison of mortality proportion (%) between mice which consumed palm oil

	L32 × L33	**L32 × L34**	**L34 × L35**
Mortality (%)	66.67-83.33	66.67-83,33	83.33-66.67
G	1.85	1.85	1.85
P	> 0.05 (NS)	> 0.05 (NS)	> 0.05 (NS)

G: value of Log Likehood ratio test
NS: no significant
L32×L33: red palm oil used as curative compare with refined palm oil used as curative
L32×L34: red palm oil used as curative compare with refined palm oil used as curative and preventive
L32×L33: red palm oil used as curative and preventive compare with refined palm oil used as curative and preventive

Table 5: Mean Hematological parameters comparison between control group Témoin 1 and control group Témoin 2

	Témoin 1 (6)	Témoin 2 (6)	t value	P
WBC (10^3/mm^3)	9.9 ± 4.69	9.77 ± 3.38	0.04	0.97
RBC (10^6/ mm^3)	7.61 ± 0.77	7.42 ± 0.71	0.32	0.76
Hemoglobin (g/dl)	11.17 ± 1.15	11.37 ± 1.14	0.21	0.84
Hematocrit(%)	37.33 ± 3.35	36.53 ± 3.67	0.28	0.79
MCV (fl)	49.33 ± 1.53	49 ± 0.0	0.38	0.72
MCH (pg)	14.6 ± 0.46	15.30 ± 0.17	2.47	0.07
MCHC (g/dl)	29.77 ± 0.4	30.87 ± 0.59	2.68	0.07
Platelet (103/mm3)	647.33 ± 203.06	953.67 ± 226.32	1.74	0.16
Lymphocyte (%)	46.67 ± 4.73	43.33 ± 18.15	0.31	0.78
Monocyte (%)	6 ± 1.73	6.33 ± 0.58	0.32	0.77
Neutrophil (%)	46 ± 6.24	46.33 ± 18.50	0.03	0.98
Eosinophil (%)	3.33 ± 0.58	4.00 ± 1.73	0.63	0.56
Basophil (%)	0.0 ± 0.0	0.0 ± 0.0		

(6): Number of mice analyzed per group; p (< 0.05): Value considered as statistically significant

Table 6: Mean hematological parameters comparison between control group Témoin 1 and control group Témoin3

	Témoin 1 (6)	Témoin 3 (6)	t value	P
WBC (10^3/mm^3)	9.9 ± 4.69	8.83 ± 5.18	0.26	0.80
RBC (10^6/ mm^3)	7.61 ± 0.77	7.12 ± 1.92	0.42	0.70
Hemoglobin (g/dl)	11.17 ± 1.15	10.33 ± 2.47	0.53	0.62
Hematocrit (%)	37.33 ± 3.35	34,43 ± 8.96	0.53	0.63
MCV (fl)	49.33 ± 1.53	48.33 ± 1.53	0.80	0.47
MCH (pg)	14.6 ± 0.46	14.57 ± 1.10	0.05	0.96
MCHC (g/dl)	29.77 ± 0.4	30.07 ± 1.26	0.39	0.71
Platelet (10^3/mm^3)	647.33 ± 203.06	759.33 ±272.27	0.57	0.60
Lymphocyte (%)	46.67 ± 4.73	46.67 ± 13.87	0.00	1
Monocyte (%)	6 ± 1.73	5.67 ± 1.15	0.28	0.80
Neutrophil (%)	46 ± 6.24	44.00 ± 13.08	0.24	0.82
Eosinophil (%)	3.33 ± 0.58	3.00 ± 1.00	0.50	0.64
Basophil (%)	0.0 ± 0.0	0.67 ± 0.58	2	0.12

(6): Number of mice analyzed per group; p (< 0.05): Value considered as statistically significant

Table 7: Mean hematological parameters comparison between control group Témoin 2 and control group Témoin3

	Témoin 2 (6)	Témoin 3 (6)	t value	P
WBC (10^3/mm^3)	9.77 ± 3.38	8.83 ± 5.18	0.26	0.80
RBC (10^6/ mm^3)	7.42 ± 0.71	7.12 ± 1.92	0.42	0.70
Hemoglobin (g/dl)	11.37 ± 1.14	10.33 ± 2.47	0.53	0.62
Hematocrit (%)	36.53 ± 3.67	34,43 ± 8.96	0.53	0.63
MCV (fl)	49 ± 0.0	48.33 ± 1.53	0.80	0.47
MCH (pg)	15.30 ± 0.17	14.57 ± 1.10	0.05	0.96
MCHC (g/dl)	30.87 ± 0.59	30.07 ± 1.26	0.39	0.71
Platelet (10^3/mm^3)	953.67 ± 226.32	759.33 ±272.27	0.57	0.60
Lymphocyte (%)	43.33 ± 18.15	46.67 ± 13.87	0.00	1
Monocyte (%)	6.33 ± 0.58	5.67 ± 1.15	0.28	0.80
Neutrophil (%)	46.33 ± 18.50	44.00 ± 13.08	0.24	0.82
Eosinophil (%)	4.00 ± 1.73	3.00 ± 1.00	0.50	0.64
Basophil (%)	0.0 ± 0.0	0.67 ± 0.58	2	0.12

(6): Number of mice analyzed per group; p (< 0.05): Value considered as statistically significant

Table 8: Mean hematological parameters comparison between control group Témoin 2 and mice which survived in group L31

	Témoin 1(6)	L31(3)	t value	p
WBC (10^3/mm^3)	9.9 ± 4.69	4 ± 0,17	2,18	0,1
RBC (10^6/mm^3)	7.61 ± 0.77	4 ± 0,48	6.89	0.0001
Hemoglobin (g/dl)	11.17 ± 1.15	6.03 ± 1.25	5.22	0.01
Hematocrit (%)	37.33 ± 3,35	20.03 ± 4.31	5.49	0.01
MCV (fl)	49.33 ± 1.53	47 ± 1.73	1.75	0.16
MCH (pg)	14.6 ± 0.46	14.17 ± 0.99	0.69	53
MCHC (g/dl)	29.77 ± 0.4	30.27 ± 0.91	0.87	0.45
Pl atelet (10^3/mm^3)	647.33 ± 203.06	245.67 ± 151.02	2.75	0.05
Lymphocyte (%)	46.67 ± 4.73	41 ± 3.46	1.68	0.17
Monocytes (%)	6 ± 1.73	6 ± 1	0.00	1
Neutrophil (%)	46 ± 6.24	48.33 ± 1.15	2.33	0.08
Eosinophil (%)	3.33 ± 0.58	4 ± 1	1.00	0.37
Basophil (%)	0.0 ± 0.0	0.67 ± 0.58	2.00	0.12

(6) or (3): number of mice analyzed per group p (< 0.05): value considered as statistically significant
p (0.01): high significant variation of probability p (0.001): very high significant variation of probability

DISCUSSION

No significant alteration of hematological parameters were observed between control mice groups (T1;T2; T3) when these parameters were compared (T1vsT2; T1vsT3; T2vsT3). These result suggested that either red palm oil or refined palm oil are non-toxic when there are consumed in food without zinc phosphide. Then, toxicity observed on mice of the experiments group is due to zinc phosphide consumption. Mortality observed in this experiment group of animal which have consumed a meal based on mixing of grilled maize powder + fish + oil (red palm oil or refined palm oil) +Zn_3P_2 was not significantly different. This result suggested that red palm oil does not get any effectiveness than refined palm oil against toxicity due to $Zn_3P_2$and vice versa. To come back to what we were saying, the chemical composition of the two form of palm oil is different by carotenoids content. Red palm oil is rich in carotenoids but refined palm oil is poor in carotenoids [7]. Carotenoids do not get any effectiveness against toxicity due to Zn_3P_2. Moreover, it was demonstrated that beta-carotene do not get any protective effect against the highly lethal phosphine gas (PH3), liberates by $Zn_3P_2$when exposed to moisture [9]. Consumption of red palm oil or refined palm oil at the same time with Zn_3P_2 are not effective against toxicity due to this product. In this condition, either red palm oil or refined palm oil do not have curative effects against intoxication due to Zn_3P_2. Palm oil constituents (anti-oxidants, fatty acid, water soluble vitamin) do not have directly a curative effect on the digestive apparatus in case of intoxication caused by Zn_3P_2 ingestion.These oil (red palm oil and refined palm oil) do not stop the intestinal absorption of phosphine gas and free radical liberated in the stomach by transformation of Zn_3P_2. Then, red palm oil and refined palm oil cannot be utilized as activated charcoal [13]. In man, oil action is most probably due to a mechanical action which provokes vomiting capable of reducing toxicity due to ingestion of a toxic product. The mechanical action is nevertheless not observed in laboratory mice. Consumption before red palm oil or refined palm oil during four weeks do not permit to reduce toxicity due to Zn_3P_2 compare to the simultaneous consumption of red palm oil or refined palm oil in diet containing Zn_3P_2.Four weeks before oil consumption is sufficient to predispose mice to fight against toxicity due to Zn_3P_2. If red palm oil or refined palm oil get some molecules with therapeutic properties against toxicity due to ingestion of Zn_3P_2, liver, being the detoxification organ of mammals was been stimulated in order to secrete enzymes. These enzymes could be able to transform Zn_3P_2metabolite (PH3 and free radical) into non-toxic metabolic. Then enzymes could also be capable of increasing the elimination of this toxic and his non-toxic metabolic by kidney [15]. Then, toxicity due to Zn_3P_2 would be reduced. We do not observe a reduction of Zn_3P_2 toxicity in this experiment. Either red palm oil or refined palm oildo not have molecules capable of raising liver faculty in detoxification action in mammal. Anti-oxidants of palm oil (carotenoids, vitamin E, and water-soluble anti-oxidant) are not capable of keeping phosphine and free radical liberated by Zn_3P_2 from destroying the organism of mammal [2, 16]. Comparison of experiments group and control group (L31) showed potentiation of toxicity due to Zn_3P_2 by red palm oil and refined palm oil. This result could be caused by lipids which are more available in the organism of mice which consumed palm oil. Lipids have the capacity of binding reversibly toxic molecules and preserve it during a long time in the organism [15]. Deleterious action of this toxic could be accentuated by oil.

CONCLUSION

Our investigation demonstrated that either red palm oil or refined palm oil have any effectiveness against Zn_3P_2 toxicity. That is justified by the lack of protective effect on mice when exposed to this toxic Zn_3P_2 at different proportion (0.4%; 0.2%; 0.1%) in diet. However, a more complete study with fewer proportion of Zn_3P_2 (0.05%; 0.005%) in diet can be used to clarify the modulation of Zn_3P_2 toxicity by palm oil. This study must include hematological and histological analysis. As a result, the fact palm oils are not effective against Zn_3P_2toxicity; it is not worth to affirm that they are not able to act as an anti-poison when used against other toxic such as chlorophacinone, chloralose, vitamin D and some toxic plant extract. It will therefore be important to carry out a more sophisticated study to cover the majority of toxic mostly used by population.

ACKNOWLEDGEMENT

We are grateful to Institute Pasteur of Côte d'Ivoire (IPCI) for providing mice and hematological analyzer. The author OUATTARA Howélé thanks Mister TOURE Kikoumany Stéphane for reviewing the redaction of the test in English.

REFERENCES

[1] Bouvenot,G., Saulnier F., Durocher A., 1996. Dermatologie, Rhumatologie, Endocrinologie, Toxicologie. Tome II, Paris *Masson*, 525-535.
[2] Brigius, F., 2005. Induction of drug metabolizing enzymes by vitamin E.J Plant Physiol162 (7): 797-802.
[3] Chugh, S.N., 1992. Aluminium phosphide poisoning : present status and management. J Assoc Physicians India 40: 401-405.
[4] Contreil, F., 2005. Look what I found! Poison hunting on eBay. ClinToxicol (Phila) 43(5):375-9.
[5] Edleston, and Person, 2003.Acute plant poisonning and antitoxinantibodies.ToxicolClin41(3): 309-315.
[6] Forget, and Goodman, 1990-1992. Impact of pesticide use on health in developping countries. Proceedings of a symposium held in Ottawa, Canada, 1-35.
[7] Ghafoorunissa, 1995. Nutrition and health implications of Palm Oil in Indian diet.Indian J. Med. Res102: 233-240.
[8] Hsu, C., Quistad, G., Casida, J., 1998. Phosphine- induced oxidative stress in Hepa 1c1c7 cells. ToxicolSci 46 (1):204-210.
[9] Hsu, C., Han, B., Liu, M., Casida, J., 2000. Phosphine- induced oxidative damage rats: attanuation by melatonin. Free Radic Biol Med15; 28(4):636-642.
[10] Mesban, H., Tayeb, E., Mourad, A., Younis, L., El Zaher, M.,Aly, M., 2003. Toxicology and histopathology of some rodenticides and palatable food items combinations on the common mice *Musmusculus var*.albus in Egypt .Commun Agric Appl BiolSci 68 (4Pt B): 771-787.
[11] Patil, R. K., Bansal, S.K., Kashyap, S., Sharma, A. K., Sharma, B., 1990. Hypoglycemia following zinc phosphide poisoning. J Assoc Physicians India 38: 306-307.
[12] Sangle, S. A., Thomas, A., Verma, S., Wadia, R. S., 1987. Zinc phosphide poisoning. J Assoc Physicians India 35: 591-594.
[13] Schorderet, M., Diezi, J, 1992. Pharmacologie. Des concepts fondamentaux aux applications thérapeutiques. Edition 2, Frisson-Roche, Slatkine, 33-43.
[14] Stowe, Nelson, R., Werdin, R., Frangmann, G., Frederick, P., Weaver, G., Arendt T. D., 1978. Zinc phosphide poisoning in dogs. Journal of AmericanVeterinary Medical Association173:270-271.
[15] Vander, A. J., Sherman, J. H., Dorothy, L. S., Goutier, J. R., 1989. Physiologie Humaine. Edition 2, Mc Graw-Hill, 629-636.
[16] Yeager, S., 2000. Guide des aliments. La santé de votre assiette : Tout savoir sur le pouvoir thérapeutique de l'aliment. Paris Marabout, 16-59.