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Short Communication

Physiological compatibility of zinc fortified apricots through sodium caseinate based edible coating

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Abstract

The current study was designed to investigate the physiological compatibility of apricots fortified with zinc (ZnO @ 40 ppm) through sodium caseinate based edible coating. Purposely, two groups of rabbits, zinc fed group (G_1) and control (G_0) were administered with zinc fortified and unfortified apricots, respectively for six weeks. At the termination, the blood of the experimental rabbits was analyzed for hemoglobin, red & white blood cells and liver & renal function tests. The results obtained after the biochemical analyses showed significant differences in AST, ALP and red & white blood cells. However, hemoglobin, urea and creatinine were affected non momentously. The findings reflected that there exist no adverse effects on physiological parameters in relation to zinc fortified apricots administration.

Introduction

Apricot (*Prunus armeniaca* L.) belonging to family Rosaceae holds its position as an important fruit in Pakistan. It is a worldwide cultivating horticultural crop bearing fruit to be eaten as fresh, dried, pitted, frozen or canned. Majorly, it is produced in Baluchistan, Malakand division and Northern areas of Pakistan (Iahtisham-Ul-Haq *et al*., 2014). Like other horticultural crops, apricot is also subjected to post-harvest losses comprising 44% of its total produce in Pakistan (Ali *et al*., 2011). However, edible coatings can be applied to curtail these losses after harvest. These are thin biodegradable coatings/ films on the surface of fresh horticultural crops resisting the environmental factors responsible for spoilage of the commodities (Valencia-Chamorro *et al*., 2010).

Zinc is an essential mineral for proper functioning of physiological systems in human body. It is imperative for various metabolic activities and maintaining healthy immune system (Raine, 2010). Inadequate zinc intake and various other factors may cause zinc deficiency in various segments of population. In this context, various strategies have been devised amongst which fortification has been shown as promising tool to rectify the dilemma of hidden hunger (Prasad, 2012).

Nowadays, safe food is of paramount concern in developed and developing countries owing to increased consumer awareness regarding food safety and recognized health problems (Henson and Caswell, 1999). Moreover, heavy metal pollution is a worldwide issue and metal interactions are very difficult to identify in living systems. Additionally, it has been seen that the uptake of various metals are interrelated to one another. Zinc being an important metal for living bodies is also related with its associated toxicity issues if present in higher amounts (Shute and Macfie, 2006). Various other health complications are also found to be linked with the use of herbal medicines because of the lack of particular regulations for their control (Ernst, 2002). In this context, fortification of zinc in any of the food product should be tested for its safety in the biological systems so that the health complications may be resolved.

Purposely, the current investigation was carried out to check the physiological compatibility of the zinc fortification in apricots using sodium caseinate based edible coatings as a carrier material. The outcomes of the research confirm the safety of the mineral when administered to the rabbits for their assessment in living system.

Materials and Methods

For the study the locally available apricots were procured from the market followed by washing to

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loosen any of the undesired adhered material to them. Afterwards, sodium caseinate based edible coating containing 40 ppm zinc (ZnO) was applied on fresh apricots (Iahtisham-Ul-Haq *et al.*, 2014). The coated apricots were then allowed to dry at room temperature for 15 minutes after coating. These coated apricots were used for administration to experimental rabbits.

Experimental design

For biosafety assessment twenty rabbits were used. The animals were acclimatized by feeding basal diet for a period of one week in a controlled environment of 12:12 hours light and dark period. Afterwards, rabbits were divided in two groups namely zinc fed group (G_1) and control (G_0) provided with fortified and unfortified apricots, respectively along with simultaneous diet provision for six weeks. At the end of trial, rabbits were slaughtered and their blood samples were collected for hematological analysis. For liver and renal function tests sera were separated by centrifugation at 2000 rpm at 4°C for 5 minutes.

Physiological compatibility tests

Following tests were conducted to check the physiological compatibility of the fortificant in living system.

Liver and renal function tests

Liver function tests including aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) were assessed using their respective commercial kits (Sigma-Aldrich). Furthermore, the serum urea (GLDH-method) and creatinine (Jaffe-method) were determined using commercial kits (Jacobs *et al*., 1996; Thomas, 1998) to assess the hepatic and renal functionality of both experimental groups.

Hematological analysis

Hemoglobin (Hb), Red blood cell (RBC) and white blood cell (WBC) in the blood of rabbits were estimated by method of Al Haj *et al.* (2011).

Statistical analysis

The data obtained for each parameter was subjected to statistical evaluation applying Completely Randomized Design (CRD) to determine the level of significance using Statistix (Version 8.1).

Results and Discussion

Physiological compatibility tests

Inclusion of any fortificant in the diet can enhance the status of that particular element in the body. On the other hand, there could possibly be some side effects of that compound that may render organs of the body to be malfunctioned so the physiological compatibility of the fortificant to the body should also be considered while administration to the living subjects. For the purpose, physiological compatibility tests including liver function tests and renal function tests were performed to check the impact of coated zinc fortified apricots on the major organs of the rabbits.

Liver function tests

The respective mean squares regarding liver function tests involving serum alanine aminotransferase (ALT), aspartate transaminase (AST) and alkaline phosphatase (ALP) are shown in Table 1. It is obvious from mean squares that a non significant difference between ALT levels for both groups was found. However, a significant difference was documented for AST and ALP levels of rabbits in both experimental groups. Furthermore, it can be deduced that there occurred a little decline in ALT values as depicted in mean values as 65.15±1.66 and 63.78±1.63 IU/L for G_0 (Control) and G_1 (Zinc fed group), respectively (Table 2). However, for AST the recorded mean values were 58.45±1.49 IU/L for G_0 and 56.57±1.44 IU/L for G_1. For ALP, a low mean value was seen in G_1 as compared to G_0 as evident from the mean values. The documented mean value of ALP for G_1 was 52.01±1.33 IU/L whilst for G_0 the observed value was 55.33±1.41 IU/L.

Liver performs numerous functions like synthesis and accumulation of various endogenous and exogenous substances, nutrients metabolism, clotting protein synthesis and detoxification. In this reference, ALT and AST are considered as important indicators of liver soundness. However during damaged or toxic conditions, these enzymes are elevated and leach out to the blood stream that can be measured to assess liver injury (Pereira *et al*., 2005; Shirakawa *et al.*, 2005). It can be assumed that inclusion of zinc improves the liver functioning as a decline in the serum ALT, AST and ALP levels that, on other hand, increase in the serum if the liver is chronically or acutely sick.

Renal function tests

Mean squares regarding renal function tests involving urea and creatinine are shown in Table 1. It is evident from the mean squares that renal functioning was not significantly affected amongst the experimental groups. In this regard, Table 2 exhibits the mean values for renal functioning tests

Table 1. Mean squares for various biochemical parameters of rabbits

SOV	df	ALT	AST	ALP	Urea	Creatinine	Hemoglobin	RBC	WBC
Groups	1	9.38450^{NS}	17.6720*	55.11*	0.11250^{NS}	0.00450^{NS}	0.12800^{NS}	4.25042*	1.6302*
Error	18	2.69763	2.1519	1.8770	0.43567	0.00131	0.08642	0.01513	0.04427
Total	19								

*= Significant ($p < 0.01$)
NS= Non significant

Table 2. Effect of fortified and unfortified apricots on various biochemical parameters of rabbits

Groups	ALT (IU/L)	AST (IU/L)	ALP (IU/L)	Urea (mg/dL)	Creatinine (mg/dL)	Hemoglobin (mg/dL)	RBC (10^6/µL)	WBC (10^6/µL)
G_0	65.15±1.66	58.45±1.49^{a}	55.33±1.41^{a}	25.98±0.66	1.37±0.03	11.60±0.30	4.4±0.11^{b}	5.50±0.14^{a}
G_1	63.78±1.63	56.57±1.44^{b}	52.01±1.33^{b}	25.83±0.66	1.34±0.03	11.44±0.29	4.8±0.12^{a}	5.02±0.13^{b}

G_0 = Control
G_1 = Zinc fed group

of rabbits that were fed with zinc fortified sodium caseinate based edible coated apricots. It can be concluded that there was a little decline in the blood urea and creatinine levels in G_1 (Zinc fed group) as evident from the mean values corresponding to urea and creatinine 25.83±0.66 and 1.34±0.03 mg/dL, respectively. However, a little higher values were observed in G_0 (Control) as 25.98±0.66 mg/dL for urea and 1.37±0.03 mg/dL for creatinine. Conclusively, the administration of zinc using sodium caseinate based coatings as a carrier channel does not interferes with the renal functionality of the subjects at a dose rate of 40 ppm.

Hematological analysis

A non momentous difference in hemoglobin amongst the groups is obvious from the mean squares (Table 1). Moreover, a significant difference is depicted by the mean squares regarding red blood cell (RBC) and white blood cell (WBC) indices. From the means (Table 2), it is inferred that hemoglobin level was documented lower for G_1 (Zinc fed group) as 11.44±0.29 mg/dL compared to G_0 (Control) for which the trailed value was 11.60±0.30 mg/dL. Consequently, there occurred a decline in the hemoglobin level in zinc administered investigational group of rabbits that could possibly be due to antagonistic interaction of zinc with that of iron that competes in the biological system for their absorption. However, a momentous increase in RBC of G_1 animals was observed as evident from the mean 4.8±0.11×10^6/µL for which G_0 value was 4.4±0.11×10^6/µL, comparatively. Furthermore, noticeable decrease in WBC was recorded in G_1 as compared to G_0. The trailed values for WBC of G_0 and G_1 were 5.50±0.14×10^3/µL and 5.02±0.13×10^3/µL, respectively.

The earlier findings of Ren *et al.* (2006) supported the current investigation as they deduced from their exploration that there occurred a decrease in hemoglobin level of rabbits fed with zinc supplemented high cholesterol diet. They trailed the role of zinc in reducing the risk of atherosclerosis development in rabbits. They concluded that inclusion of zinc in diet reduced the atherosclerotic lesions area in animals as compared to those who were fed with high cholesterol diet having no zinc. El Hendy *et al.* (2006) probed the variations in hematological and biochemical attributes of rats during dietary zinc deficiency and found that there was a significant difference between the heamoglobin levels of the control and zinc deficient diet fed rats. They concluded that the dietary deficiency causes diminution in hematological parameters like RBC and TLC etc. Zinc is indispensible in immune system as its deficiency causes impaired immune responses with loss of integrity of T-cells. Zinc also effects the proliferation and maturation of lymphocytes hence its deficiency leads to compromised immunity.

Conclusion

From the current investigation it can be concluded that administration of zinc (ZnO) through edible coating (sodium caseinate based) was safe in biological system. The physiological system was not

adversely affected by the inclusion of diet with zinc fortified apricots in experimental groups. It can be narrated that the use of edible coatings as a carrier of fortificants can be a possible strategy to mitigate the dilemma of under nutrition. Nevertheless, extensive research is still needed to explore the potential of edible coating mixtures with various compositions to carry multiple nutrients simultaneously.

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