Effect of Ultraviolet radiation on mineral composition of hair and nails of mammals (Labrador retriever) in different age group

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Abstract

The UV component of sunlight is well known to cause serious issues for skin and hair like photoaging, erythema, edema, skin thickening, wrinkling, loss of shine and strength of hair, etc, by triggering the generation of ROS, degradation of proteins, peroxidation of lipids. When the levels of important elements like N, P, Ca, Fe, Mg and Cu were estimated in the nails and hair of pet dogs relying on a normal diet, the concentration of all these elements was considerably lower on increasing age of dogs. The data suggest that UV exposure has a negative effect on the concentration of elements with respect to age.

Objectives : The main objective of current work to study the effect of ultraviolet radiant light on mineral composition of hair and nails of mammals which is responsible for aging.

Material and method : This study involve two age group of dog variety (Labrador retriever) which having age (4-6) and (9-12).

Keyword : Labrador retriever, aging, vitamin, mineral.

Introduction

Skin is the largest organ of the human physical structure and the primary organ of defense [Panich et al., 2016]. It is constantly exposed to the environment and hence significantly influenced by environmental stresses. Though sunlight is the ultimate source of energy and is necessary for the existence of life on earth, nevertheless, the ultraviolet (UV) fraction of sunlight is deleterious to health. The wavelength of these high-energy electromagnetic waves lies in the range of 380 nm to 10 nm. The ozone layer protects the planet from harmful UV radiation, yet increased UV radiation is one of the environmental challenges that affect people's health globally [Sherry, 2019]. In the presence of atmospheric oxygen, these rays trigger the production of Reactive Oxygen Species (ROS) causing the oxidation of the protein and lipid content of the hair leading to hair damage [Grosvenor et al., 2016; Hoting et a., 1996], premature aging of the skin (photoaging), erythema, skin pigmentation, cancer and several more serious diseases related to the exoskeleton of mammals [Dreher et al., 1998].

The minerals are necessary to build animal tissues, maintain normal physiological processes and also reflect the metabolism of nutrients in the body [Chitturi et al., 2015]. The consistency of the chemical constitution of the body is

most crucial and obligatory state for proper functioning because variations in the concentrations of chemical substance brought on by environmental, occupational, climatic, or geographical factors are the root cause of various disorders [Avtsyn et al., 1991; Skal'nyi, 1999]. Recent research reveals that changes in trace metal levels may affect the incidence and occurrence of chronic diseases like cancer [He, 2011].

The selection of a sample to detect the trace element in the body is an important step and various samples can be used for this purpose [Esteban and Castaño, 2009; Nagornaya and Dubovaya, 2006], however, all the samples are bound with certain advantages and disadvantages. Nails are epidermis-derived body parts mainly composed of keratin-rich protein and accumulate trace metals proportionately to their intake through a variety of methods, including the production of proteins with sulfha hdryl groups. Owing to fact nails are considered a helpful marker for trace metal analyses and are progressively being used in clinical trials [Janbabai et al., 2018]. Another skin-derived body part is hairs which are also a metabolic end product. Hairs have a particular potential to demonstrate the body's metallic load. The amount of certain trace elements present in hair reveals a balanced mineralized content of the body over a long period. Thus, for trace element analysis, both the samples have several advantages *viz.* the sampling is noninvasive, portable, and can be stored for a long time without special conditions; using these samples, both short- and long-term effects can be assessed, and the dynamics of substance accumulation can be determined [Esteban and Castaño, 2009; Were et al., 2008]. We sought to investigate the effect of the UV radiation present in sunlight on the level of few selected elements in nails and hairs. Hence in the present study dogs (variety: Labrador retriever) were selected to study the effect of UV exposure on the trace elements in nails and hair samples.

Materials and methods

Animals and diet: In the current study pet dogs of the Labrador retriever variety were used as animal models. All the dogs were healthy of age group (4-6) and (9-12).Which having a body weight under 5-14 kg. The dogs were randomized and divided into two groups based on their age.

Sample collection: Hair and Nails samples were collected from healthy, disease-free dogs (variety: Labrador retriever) which are from a nearby pet seller shop. The nails are cut by a veterinary doctor in a definite proportion by using a sterile volute (veterinary hospital) nail cutter. Samples were collected by cutting the terminal portion of nails and special precaution was taken to avoid damage to the nail plate. Subsequently, the nails were stored in airtight sample bottles (Lapro technologies, Mumbai, India) and used for further analyses. Hair samples also collected under the observation of Dr. Munendra pal belong to vaterinary hospital Mathura.

Determination of the mineral composition of nail samples: The mineral composition in nail samples was determined by using the Atomic absorption spectroscopy technique and U.V. visible spectrophotometer. Firstly, the sample was converted into ash by using a muffle furnace at 550 °C by using ammonium nitrate because it helps to remove other minerals which are not detectable. Then collect ash and treat it with hydrochloric acid then all mineral ion is converted into their chlorides. These chlorides undergo filtration and are analyzed by using PE5000

atomic absorption spectroscopy. Phosphorous is determined by using vando-molybdate reagent calorimetrically at a wavelength of 420 nm. The measurement of other minerals takes place by using U.V. visible spectrophotometer recording their samples at different wavelengths in the range of 200-400 nm. Every ion shows a peak at a certain wavelength in spectra.

Determination of mineral composition on Hair samples: The mineral composition in hair samples was determined by using AAS technique and U.V. visible spectro photometer. Firstly the sample of hair is placed in bleaching solution which consist 9% hydrogen peroxide(H_2O_2) and 1% ammonium sulphate solution for three hours with constant stirring then wash it with water and dried it in air. By this process the extra colour and impurities present on hair get rinsed off. Then hair placed in 2.5% Na OH solution for 30 minutes and rinsed with distilled water and dry it at room temperature. Then, placed it into muffle furnace at 540^0c temperature and convert it into powder and estimated the mineral composition by using AAS technique.

Result: To conduct this study we selected N, phosphorous, Mg, Ca, Fe, and Cu as markers of hair and nails health as these elements have crucial roles in the physiology of the whole body. Nitrogen is an imperative part of proteins of the body, phosphorous promotes the growth and repair of all the cells including skin, hair, and nails. Calcium is important for healthy hair, nails, and the repair of all damaged tissue, while Mg is directly involved in hair growth and calcium buildup in hairs. Rest are rare element which found in nails and hair of mammals.

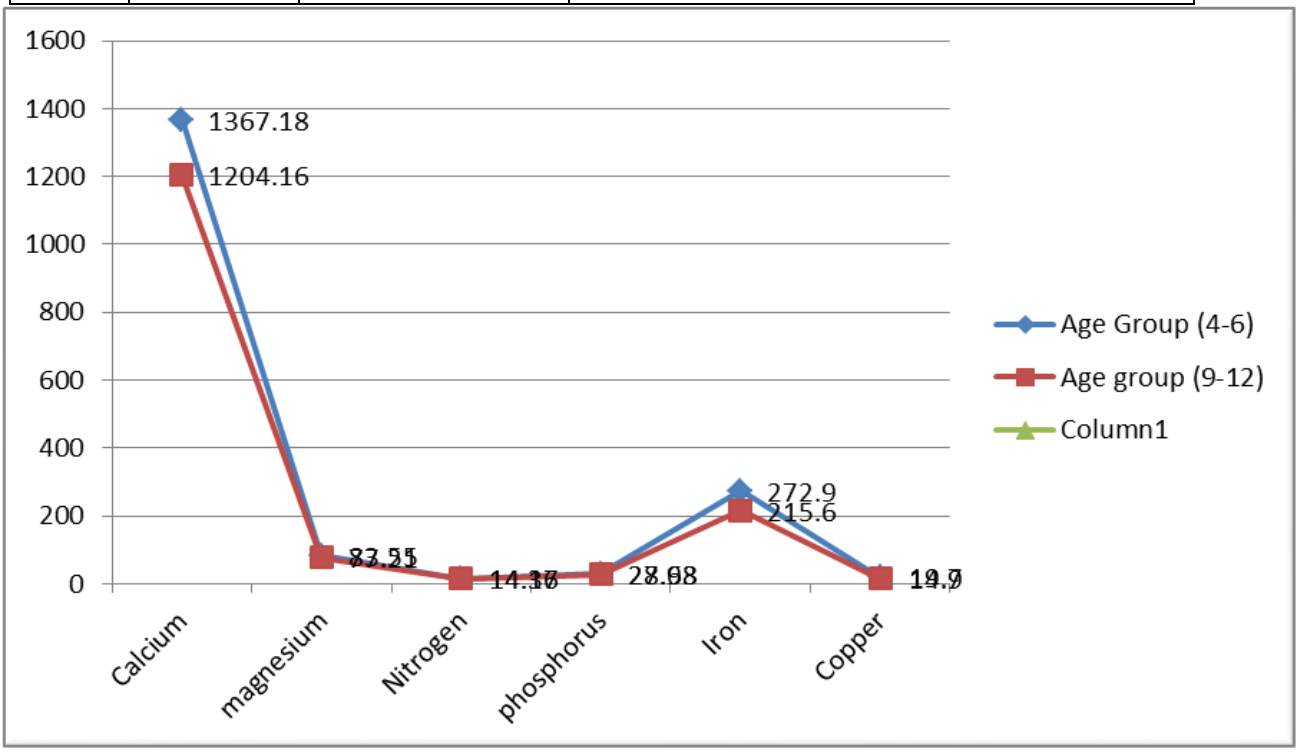
Effect of UV exposure on elemental status in hair

Table 1 represents the estimation of elements in hair samples of dogs in different age group. In the case of dog with age group, (9-12) it was evident from the data that Calcium was the most abundant element, which was quantified as 1204.16 mg/100 g hair followed by Magnesium (77.21 mg/100 g hair). Nitrogen (N) and Phosphorous (P) were found at the concentrations of 14.17 and 27.68 mg/100 g hair and Iron and copper contain 215.6 and 14.9 mg /100 mg respectively. Interestingly, when these elements were analyzed in hair samples of dogs with age group (4-6) the quantity of each element was considerably higher (Ca, 1367.18; Mg, 83.55; N, 14.36; P, 28.93, Fe,272.9 and Cu,19.7 mg / 100g hair).

Table 1: Estimation of elements in hair samples

S no	Element	Quantity mg/ 100 g hair	
		Age group (9-12)	Age group (4-6)
1	Calcium	1204.16	1367.18
2	Magnesium	77.21	83.55
3	Nitrogen	14.17	14.36

4	Phosphorus	27.68	28.93
5	Iron	215.6	272.9
6	Copper	14.9	19.7



Graph:1 Varition in mineral composition of hair sample (Labrador retriever) at different age group.

Effect of UV exposure on elemental status in nail

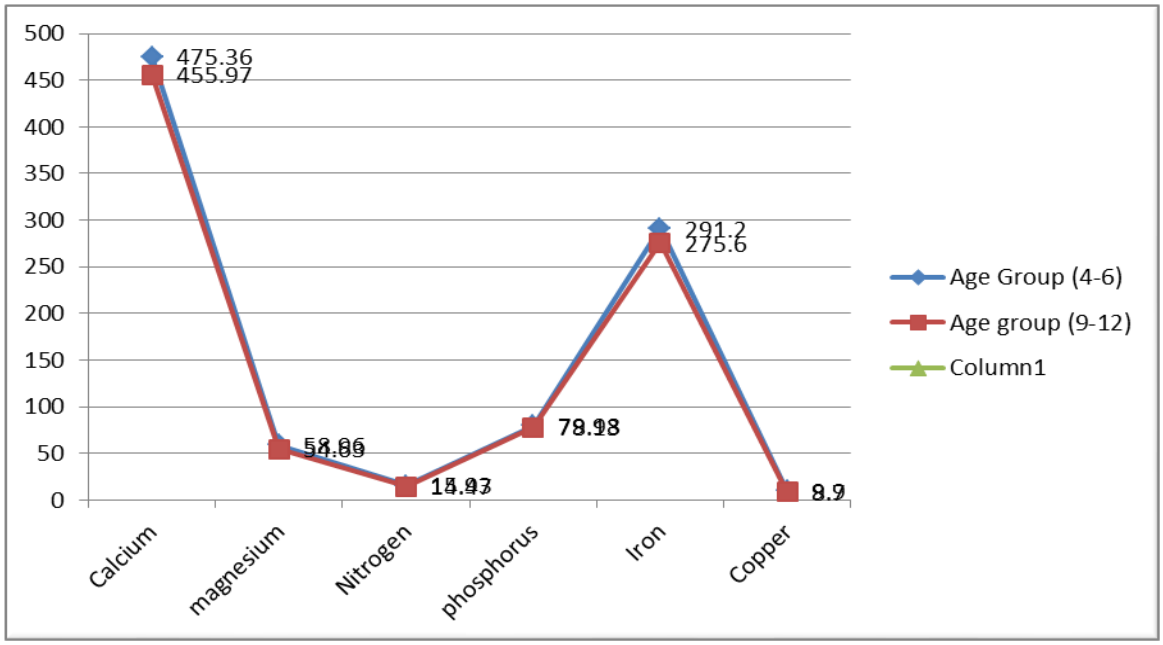
Similar to hairs, the same elements were analyzed in the nails of both groups. In nails, the amount of Ca was highest (455.89 mg/100g) followed by P (78.13 mg/100g). The quantity of N was comparable to hair (14.47 g/100g). The amount of Mg was estimated as 54.63 mg/100g and iron and copper (275.6 and 8.7g/ 100g). On the other hand, the second age group of dog variety(4-6) show resulted in a significant increase in the concentration of all the elements as in the case of hair (Table 2).

Table 2: Estimation of elements in nail samples

S no	Element	Quantity mg/ 100 g hair	
		Age group (9-12)	Age group (4-6)
1	Calcium	455.89	475.97
2	Magnesium	54.63	58.96
3	Nitrogen	14.47	15.93
4	Phosphorus	78.13	79.98
5	Iron	275.6	291.2

6	Copper	8.7	9.9

The graphical representation of above data help to understand with change in mineral concentration with respect to age more easily.



Graph:2 Variation in mineral composition of nails sample (Labrador retriever) at different age group.

Discussion

The depletion of the ozone layer is a major environmental problem for the world, due to which there is an enhancement in the UV radiation reaching the earth, which causes several serious problems to humans as well as animals. The hairs and nails are part of the skin which are maximally exposed to UV radiation. Hence hairs and nails face the most detrimental effects of UV radiation along with the skin. The UV fraction of sunlight weakens hair fibers and causes damage. Keratin (the hair protein) and melanin pigments are damaged by UV-B, and the interaction of endogenous photosensitizers with UV-A results in the production of free radicals and reactive oxygen species [Fernandez et al., 2012]. All these reactions ultimately cause serious damage to the skin, nails, and hair.

In recent decades, there has been an increase in awareness of the significance of trace metals in matters relating to human health. By altering enzymatic activities or the permeability of cell membranes, trace metals are advantageous nutritional components that function as crucial cofactors in physiological processes [He et al., 2011]. Owing to the fact in the current study, we selected pet dogs as study models, and hair and nails as sample tissue to study the effect of UV radiation. In several previous studies, these body parts have been used to determine the trace elements in the biomedical and environmental sciences [He et al., 2011; Sherry, 2019]. Previously, a similar study was conducted on human hair by Fernandez et al [2012]. The authors exposed the hair samples to UV light and various parameters

like protein and amino acid degradation, lipid peroxidation, color and shine changes, and strength/relaxation properties. All the parameters were worsened after UV treatment and we found that on incresing age the exoskeleton of mammals become dry and more sensitive to U.V. radiation that's why the concentration of minerals become decreased and effect of U.V. become increases. The generation of ROS by UV light is supposed to be one of the main reasons for photo aging. The exogenous supply of antioxidants through diet and/or skin pretreatment can inhibit the photoaging process [Petruk et al., 2018].

Conclusion

Like humans, domestic animals are also constantly exposed to UV radiation. The consequences of UV radiation in these pet animals can be correlated to humans also. The data suggested that UV exposure decreased the levels of essential elements in hair and nail samples. The U.V. exposure show the negative effect on the health of hair and nails of mammals and responsible for premature aging of species.

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