Peripheral leukocytic responses to ultraviolet radiation in pre-pubertal rabbits fed organic turmeric-supplemented diet


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Antioxidant/anti-inflammatory impact of organic turmeric (Curcuma longa) to enhance developmental resilience has been evaluated in stress induced, ultraviolet (UV) irradiated (R) rabbits indexed by peripheral leukocytic responses. This study was conducted for a total of 85 days (d) in three (3) phased periods: 40d pre-irradiation, 5d irradiation and 40d post-irradiation in 60 acclimatized pre-pubertal, unsexed rabbits of average body weight of 600g randomly assigned to 5 groups of 12 rabbits each and treated as follows: Group 1, served as control and were fed unsupplemented diet and forage (Tridax procumbens) - basal diet (BD) for the entire study period without any treatment. Group 2 rabbits were fed BD supplemented with 2% crude pulverized turmeric (T) during periods 1, 2 and 3, but were not irradiated. Group 3 rabbits were fed unsupplemented BD at periods 1, 2 and 3 and irradiated. Group 4 rabbits were fed supplemented BD during periods 1 and 2 only and irradiated. Group 5 rabbits were fed BD in periods 1 and 2, irradiated at period 2 and served supplemented BD at period 3. Blood was collected on the 86th day from 09.00h. Feed and water were available ad libitum. The experimental design was completely randomised block design. Data were analysed by ANOVA with graphic post-hoc test of significance. The study results suggest that UV irradiation significantly (p<0.05) suppressed WBC and absolute lymphocytic count. Organic turmeric supplementation significantly ameliorated these potentially deleterious UV effects (p<0.05).

Key words: Turmeric, Leukocytic-response, Ultraviolet Radiation, Rabbits.

INTRODUCTION

Ultraviolet (UV) radiation within sunlight is an important part of the solar energy reaching the earth surface. It is likely the most important environmental immune suppressant to which human, animal and the environment is exposed (Duthie et al., 1999; Halliday et al., 2011). It is an environmental genotoxic agent that causes cellular DNA damage (Schuch and Menck, 2010) by presenting mutagenic and carcinogenic properties (Stary and Sarasin, 2000).

The human skin is regularly exposed to UV radiation from the sun or artificial light sources with some of the rays penetrating the epidermis and reaching the papillary dermis, negatively impacting the cutaneous peripheral leucocytes that are preferentially located around the capillaries in the papillary dermis, epidermal and sub-epidermal layers (Matsumura and Ananthaswamy, 2004).

The increase in solar UV radiation at environmental level, due to depletion of the stratospheric ozone layer (Mayer, 1992) has a more dramatic effect in tropical and subtropical regions. It is responsible for potential acute effects and health hazards as cutaneous erythema, a local photosensitivity reaction; impairment of specific and non-specific immune responses and oxidative stress (Kripke, 1984; Savoure et al., 1996; Kitazawa and Iwasaki, 1999; Gill and Kim, 2000; Bardak et al., 2000) with dose...
dependent functional changes in various physiological systems in animals. Indeed, exposure to UV suppresses the resistance against both systemic and non-skin-associated local infections, as well as causing a variety of molecular changes that lead to immune-suppression, down modulation of pre-existing cell-surface receptor, resulting in suppression of some important functions of circulating phagocytic cells (Goettisch et al., 1996; Halliday et al., 2011).

Traditional herbs seem to enjoy more acceptance than the prescription drugs currently in some cultures, resulting in considerable public and scientific interest in the use of plant derived products (phytochemicals) as prophylactic and therapeutic agents against a wide range of diseases (Kapakos et al., 2012). In addition, a number of dietary antioxidants e.g. flavonoids (a group of polyphenol compounds) exist beyond the phytochemicals. Such antioxidants are widely found in plants as glucosylated derivatives within the leaves, flowers, fruits, seeds, spices, medicinal plants and beverages. They are known to exhibit various biological effects such as anti-humoral, anti-ischaemic, anti-hepatotoxicity and anti-inflammatory activities (Shu, 1998).

Turmeric, with curcumin as the main active ingredient, is a tropical plant and a mandatory condiment in every Indian kitchen, extensively used as a spice and food preservative as well as a household remedy for diseases (Eigner and Scholz, 1999). Curcumin has been documented to exert beneficial effects in multiple pathological conditions as well as possessing anti-inflammatory and anti-oxidant properties (Singh et al., 2004). When applied as capsules to patients with respiratory diseases, it gives relief for symptoms like dyspnoea, cough and sputum. In combination with other plant products, curcumin purifies the blood and assists in menstrual and abdominal problems (Eigner and Scholz, 1999). Chattopadhyay et al. (2004) reported that both turmeric and curcumin are well tolerated at high doses without any toxic effect. According to Al-Noori et al. (2011), Curcuma longa powder at 1% supplementation of basal diet increased WBC in broiler chickens.

Against this background, this study investigated the responses of peripheral leucocytes to whole-body ultraviolet radiation and the ameliorative effect of organic Turmeric-supplemented diet.

**MATERIALS AND METHODS**

**Experimental Site**

The experiment was carried out at the Rabbitry unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

**Housing**

The rabbitry with the cages were cleaned and disinfected. Cleaned and disinfected earthen feeders and drinkers were placed in each hutch before the rabbits were introduced into the hutches.

**Design of Ultraviolet Radiation Chamber**

The UV box was designed in such a way that the activities taking place within the chamber could be observed through one of the sides of the box fixed with a transparent glass while all the other sides, including the entrance door side, were made of wooden planks, covered with asbestos sheets. To prevent heat loss, the whole chamber, except the glass view side, was covered with a black polythene sheet as shown in Figure 1. Dimension of the Ultraviolet radiation box is 1.07m by 0.6m by 1.08m. The dosage of ultraviolet radiation received by each rabbit was calculated, using the formula by Podgorsak (2005), with reference to the body weight of the rabbits thus:

\[
Dose = \frac{2PAt \tan^{-1}(L)}{MLd \cdot (2d)}
\]

**Processing of Turmeric**

Organic turmeric rhizome was purchased from a certified organic farm at Odogbolu, Ogun State, Nigeria. The rhizomes were washed clean of sand and parboiled. They were sliced thinly and air-dried before milling into...
fine grains. The grains were sieved through a cheese cloth to produce a uniform sized powder, which was added to the concentrate as test ingredient at 2% inclusion rate.

Rabbits and their management

Sixty unsexed pre-pubertal rabbits, obtained from a reputable local rabbitry were weight-balanced into five (5) groups of twelve (12) rabbits each, randomly allocated into five different feeding groups and offered concentrate feed plus or minus 2% turmeric supplementation before, during and/or after exposure to ultraviolet irradiation as shown in Table 1. The rabbits were daily offered generous supply of wilted *Tridax procumbens* plants as forage. Feed and water were supplied *ad libitum*.

Duration of Study

The experiment lasted eighty five (85) days in three phased periods of 40days (pre-irradiation), 5 days (irradiation) and 40days (post-irradiation).

Experimental Design and Statistical Analysis

The experimental design was completely randomised block design. Data were analysed by Analysis of Variance (ANOVA) with graphic post-hoc test of significance.

RESULTS

The results of this study are presented in Table 2. Animals that were fed organic turmeric throughout the
Table 1. The various experimental Treatments.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>n</th>
<th>TREATMENT PHASES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Turmeric (T)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(40 days)</td>
</tr>
<tr>
<td>CONTROL</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>T + T + T</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>- + R + -</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>T + TR + -</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>- + R + T</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

n, number of animals per group = 12; + = plus; - = minus.

Table 2. Leucocytic responses of pre-pubertal rabbits fed organic turmeric-supplemented diets and exposed to ultraviolet radiation.

<table>
<thead>
<tr>
<th>S/N</th>
<th>GROUP</th>
<th>n</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CONTROL</td>
<td>6.00 ± 1.01&lt;sup&gt;†&lt;/sup&gt;</td>
<td>69.12 ± 6.0</td>
</tr>
<tr>
<td>2</td>
<td>T + T + T</td>
<td>5.88 ± 0.80&lt;sup&gt;ns&lt;/sup&gt;</td>
<td>77.72 ± 4.60&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>- + R + -</td>
<td>4.53 ± 1.18&lt;sup&gt;ns&lt;/sup&gt;</td>
<td>71.93 ± 3.34&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>T + TR + -</td>
<td>6.85 ± 1.09&lt;sup&gt;ns&lt;/sup&gt;</td>
<td>68.87 ± 6.27&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>5</td>
<td>- + R + T</td>
<td>5.78 ± 0.91&lt;sup&gt;ns&lt;/sup&gt;</td>
<td>70.64 ± 5.96&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

n, number of animals = 12; † mean ± SEM; *p<0.05 vs control; **p<0.05 vs UV irradiation; not significant (ns) vs control. T, Turmeric; R, UV irradiation; LYM, Lymphocyte; ABS, Absolute lymphocyte count.

Experimental period without exposure to radiation (group 2) had similar leukocyte count to that of the control (P>0.05). The WBC (leukocyte) count for rabbits that were irradiated but were not fed organic turmeric either before or after irradiation was significantly (P<0.05) lower than that of the control and other treatment groups. The rabbits that were fed turmeric throughout the experimental period but were not irradiated had the highest and statistically significant (p<0.05) lymphocyte count compared to the control (group 1) and the irradiated but unsupplemented (group 3). The lymphocyte counts for other treatment groups were not significantly different from one another nor from the control (P>0.05).

**DISCUSSION**

The significantly lower value recorded for the leucocytes count in Group 3 rabbits (fed unsupplemented basal diet at period 1, 2 and 3 and irradiated) than Group 1 rabbits (control-fed basal diet at periods 1, 2 and 3 but not irradiated) in this study is an indication of a reduction in the circulating peripheral leucocytes, consequent upon the exposure to UV radiation. While there was no significant difference between Group 3 and Group 1 in the percentage of lymphocyte in the leucocytic differential count, the rabbits in Group 3 recorded a significantly lower value than the control in both the Leucocyte and absolute lymphocyte counts. These results are consistent with those of Matsumura and Ananthaswamy (2004) that normal lymphocytes are highly sensitive to the damaging effect of UV radiation and undergo cell death.

Bos et al. (1987) and Matsumura and Ananthaswamy (2004) reported that some of the UV rays from the sun or artificial light sources penetrate the epidermis and reach the dermis to affect the peripheral leucocytes, down modulating pre-existing cell-surface receptors. This also results in impairment of specific and non-specific immune responses as well as cause oxidative stress and functional changes in various physiological systems at increased doses (Kripke, 1984; Savoure et al., 1996; Kitazawa and Iwasaki, 1999; Bardak et al., 2000 and Gill and Kim., 2000). The reported high sensitivity of lymphocytes to UV radiation has been responsible for markedly reduced proliferation and inhibition of responsiveness to mitogen (Deeg et al., 1989). UV exposure has also been reported to impair the immunological resistance to viral, fungal, bacterial infections, parasitic diseases and antigenic tumours (Sleijffers et al., 2004, Loveren et al., 1996; Goettsch et al., 1998) and generally exhibited suppressive effects on some humoral and cellular immune parameters in rats (Cetin and Altinsaat, 2006).

The significantly higher value recorded for group 4 (fed supplemented BD during periods 1 and 2 only and irradiated) and group 5 (fed BD in periods 1 and 2 and
irradiated at period 2 following which supplemented diet BD was served in period 3) over group 3 rabbits suggests that the supplementation with organic turmeric potentially conferred both prophylactic and therapeutic effects on the rabbits (before and after exposure to the UV rays respectively). Turmeric, through its main active ingredient (curcumin), has been implicated in disease remedy, antioxidant and anti-inflammatory properties including the exhibition of various biological effects such as anti-humoral, anti-ischaemic and anti-hepatotoxicity activities (Ammon and Wahl, 1991; Eigner and Scholz, 1999; Motelini et al., 2000; Singh et al., 2004).

In conclusion, the results of this study strongly suggest that UV irradiation significantly (p<0.05) suppresses WBC and absolute lymphocytic count. Organic turmeric supplementation significantly ameliorates these potentially deleterious UV effects. More studies are currently underway to further delineate the prophylactic and therapeutic efficacy of Turmeric.

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REFERENCES


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