

## **STUDIES ON THE EFFECTS OF LYCOPENE IN POULTRY (*HEN AND QUAIL*)**

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### **Introduction**

Lycopene is a member of the carotenoid family as an acyclic isomer of beta-carotene but has no vitamin A activity. This pigment is responsible for the red color of tomato and its products. Beside the coloration effects lycopene has one of the highest antioxidant activities of all the carotenoids (13). Non-antioxidant mechanisms have also been proposed. These are: upregulation of connexin 43 (gap junction protein) expression (6), suppression of carcinogen-induced phosphorylation, inhibition of cholesterol synthesis in the HMG-CoA depending step (1) and stop cell division at the G<sub>0</sub>-G<sub>1</sub> cell phase. Because lycopene may have anticarcinogenic and antiatherogenic activities a lot of studies focused its effects. Most of the studies deal with aspects of human health (i.e. prostate and lung cancer) (7, 12) and less in animal science. For example a fresh tomato was added into the chicks' diet in order to evaluate its chemoprotective effect against cytotoxicity of T-2 toxin (9). Some effects of lycopene were investigated in model experiments on Japanese quail in our present study.

### **Materials and methods**

Experimental animals and arrangements:

Adult Japanese quail layers were kept in batteries, under natural light. One group (control) was fed with commercial laying fodder and another with special fodder mixture. It was carotenoid and retinoid free but its main properties (energy, crude protein, minerals etc.) was the same. Tomato pasta was added to this experimental mixture resulted 1.55 mg/g concentration for lycopene. The immunization protocol was carried out on Bovans Nera hens.

Methods:

Lycopene content of tomato paste was calculated by molar absorption coefficient at OD505 nm of hexane extract (11). The color of egg yolks were measured by Yolk Color Fan (Hoffmann La Roche). Retinoids were analyzed by HPLC (8); IgY-titer was determined by

ELISA (10) techniques. Blood lipids were determined by enzymatic Reanal Kits. For the characterization of antioxidant status we measured the TBA reactive substances (5) and the FRAP values (2) of blood.

### Results and discussion

The color of egg yolks in the lycopene supplemented group increased markedly. The Yolk Color Fan scores in the control group was fall rapidly (Fig. 1). This phenomenon proves that the lycopene can be utilized for quail from the tomato paste. Lycopene in processed foods, in our case tomato paste, is mainly in the form of the cis-isomer. The improved availability of lycopene from processed foods is due to its release from the ruptured plant cells following the mechanical and thermal processing, as well as heat induced-trans to cis isomerization. Cis-lycopene is reported to be more bioavailability than trans-lycopene. (3).The pigment not only absorbed but via circulation reached the ovary and deposited into the growing follicles.

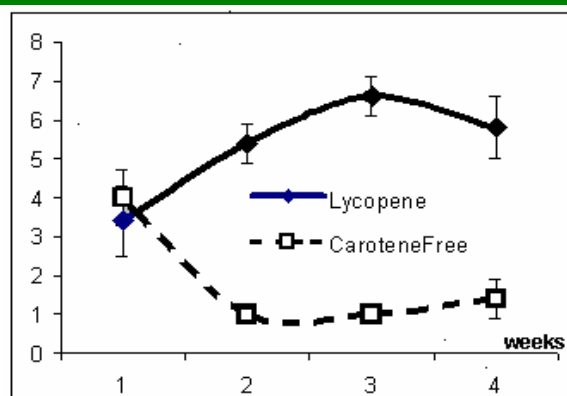


Fig. 1. Yolk Color Fan values

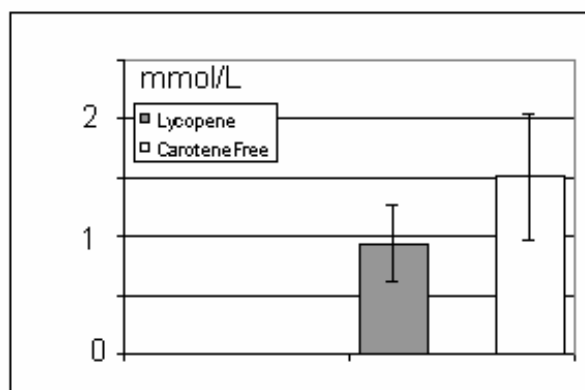


Fig.2 Total cholesterol in blood

Blood triacyl glycerol (TG) concentrations were not differing between groups. The blood total cholesterol decreased significantly ( $p < 0,01$ ) in the lycopene supplemented layers (Fig. 2). Lycopene has been found to inhibit cholesterol synthesis, to inhibit HMG-CoA (hydroxymethylglutaryl coenzyme A) reductase activity (1). Probably this inhibition was in the background the decreased cholesterol value in the lycopene group.

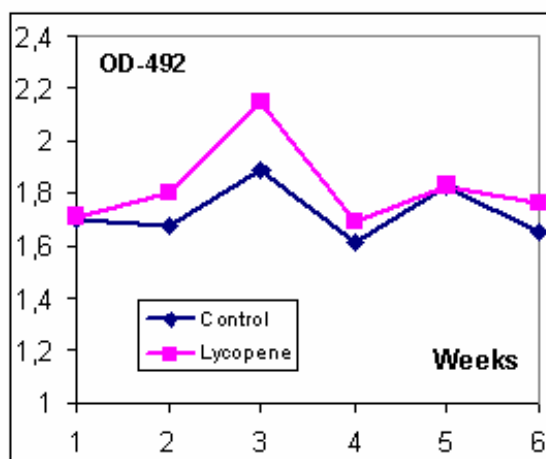


Fig.3. IgY-titer in blood

Blood retinoids (retinol and its esters) decreased by the 4th week (end of experiment) indicating that the fodder of both groups was absolutely free from preformed vitamin A and /or provitamin carotenoids as well. Lycopene is an acyclic

isomer of beta-carotene. Beta-carotene, which contains beta-ionone rings at each end of the molecule, has provitamin activity. In contrast to beta-carotene, lycopene has no vitamin A activity and thus is a nonprovitamin A carotenoid.

The immune response of Bovans Nera layers (n=6) were challenged by bovine serum albumin (BSA) with i.m. injection. Three layers were feed by lycopene supplemented fodder. The others served as controls. Blood samples were titrated by ELISA against the antigen (BSA). The IgY titers were elevated both group. The elevation in the lycopene treated animals was considerably higher (113%) by the second week (Fig.3.). In a controlled trial, 15 mg of lycopene significantly increased NK cell concentration, but no other immune functions (4). We found an increased humoral response in our experiment. This simulative effect indicates that the immune competent cells and tissues have more effective function if the lycopene input is continuous by fodder. It was described by others as lycopene showed its protective effect on immune response and reduced the cytotoxicity induced by T-2 toxin in chicken (9).

Lycopene has the ability to quench singlet oxygen (more so than beta-carotene), to trap peroxy radicals, to inhibit the oxidation of DNA, to inhibit lipid peroxidation which are harmful for the cellular metabolism (13). Probably these actions prevent from the oxidative damages the competent cells during the antigen processing instead of that nether the TBA-reactive substances nor the FRAP values were not differ significantly between lycopene and carotene free groups.

From our preliminary investigation we can conclude that the lycopene containing tomato produce, maybe some byproduct of processing could be use in the poultry nutrition.

## References

1. Agarwal S., Rao A.V.: *Tomato lycopene and low density lipoprotein oxidation: a human dietary intervention study - Lipids.* 1998; 33:981-984.
2. Benzie I.F., Strain J.J. - *The ferric reducing ability of plasma (FRAP) as a measure of "antioxidant power": the FRAP assay -Anal Biochem.* 1996 Jul 15; 239(1):70-6.
3. Boileau, A.C., Merchen, N.R., Wasson, K., Atkinson, Ch.A. Erdman, J.W.: *Cis-Lycopene Is More Bioavailable Than Trans-Lycopene In Vitro and In Vivo in Lymph-Cannulated Ferrets J. Nutr.* 129: 1176-1181. 1999.
4. Corridan B.M., O'Donohue M.P., Morrissey P.A.: *Carotenoids and immune response in elderly people. Proc Nutr Soc* 1998; 57:3A-4A.
5. Dorman H.J., Deans S.G., Noble R.C., Surai, P.: *Evaluation in vitro of plant essential oils as natural antioxidants - J. Essent. Oil. Res.,* 7:645-651. 1995
6. Forbes, K., Karin Gillette, K., Sehgal, I.: *Lycopene Increases Urokinase Receptor and Fails to Inhibit Growth or Connexin Expression in a Metastatically Passaged Prostate Cancer Cell Line: A Brief Communication – Exp. Biol. Med.* 228:967-971. 2003.
7. Gann, P.H., Ma, J., Giovannucci, E., et al.: *Lower prostate cancer risk in men with elevated plasma lycopene levels: results of a prospective analysis. Cancer Res.* 59:1225-1230. 1999.
8. Kerti Annamária, Bárdos L.: *Storage of Retinoids and Beta-Carotene in Genital Organs of Japanese quail - Acta Vet. Hung.,* 47 (1) 95-101 1999.

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9. *Leal M., González E.M., Tsutsumib,V., Shimadac, A., Ruizc, F.: Chemopreventive effect of lycopene on cytotoxicity of T-2 toxin in vivo - Cancer Detection and Prevention Online - abstract No.262 (http://www.cancerprev.org/Journal/Issues/26/101/1096/4414)*
10. *Losonczy S., Szabo Cs., Kiss Zsuzsanna, Bárdos L.: Application of an anti-HQIgY antibody for the measurement of IgY concentratuon of hen's and quail's serum and yolk - Acta Physiol. Hung., 86 (3-4) 253-258. 1999.*
11. *Merck Index, Merck & Co, Rahway, N.J. USA. 1989.*
12. *Michaud, D.S., Feskanich, D, Rimm, E.B., et al.: Intake of specific carotenoids and risk of lung cancer in 2 prospective U.S. cohorts. - Am J Clin Nutr. 72:990-997. 2000.*
13. *Rao A.V., Agarwal S.: Bioavailability and in vivo antioxidant properties of lycopene from tomato products and their possible role in the prevention of cancer. - Nutr Cancer. 1998; 31:199-203.*