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THE BIOACTIVITY OF EGG YOLK PROTEINS

A GENERAL REVIEW OF THE SCIENTIFIC LITERATURE

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Executive Summary

Ecovatec’s revolutionary technology has unlocked the amazing potential of egg yolk protein peptides (YPP). Our egg yolk protein peptides include at least 25% phosvitin phosphopeptides as well as small amounts of phospholipids. YPP is isolated using **sustainable EcovaPure™** technology from commercial egg yolk and the proteins are hydrolyzed into its bioactive peptides. Bioactivity is based on the ability of a compound to be “able to exert a biological effect at a physiological level, and it must be measurable and able to provide health benefits.”¹ The scientific community has done extensive research on the benefits and applications of egg yolk peptides, however it has not specifically investigated the specific combination of peptides found in YPP. Ecovatec is confident that **YPP exerts the same range of bioactive effects phosvitin peptides** have come to be famous for through an analysis of our processing methods and product yields. However, we also have investigated the bioactive functions of YPP. This paper will summarize this research and discuss the studies performed on blends of egg yolk peptides.

Background

Egg yolk protein peptides (YPP) are derived from **phosvitin and lipovitellin proteins**.¹ Proteins are made up of peptides, which are short chains of amino acids linked by peptide bonds. Breaking these bonds through **hydrolysis** allows us to obtain a blend of peptides of various sizes. Bioactive peptides are ones that have shown the most promising potentials as therapeutic or health promoting agents.²

Serine is the major amino acid present in phosvitin (50%), and almost all the serine residues are phosphorylated. This phosphorylation gives phosvitin its unique properties, including its strong **antioxidant, antiviral, antibacterial, anticancer, and metal chelating** properties.²⁻⁵ While full-protein phosvitin exhibits some of these properties, it is only when it is hydrolyzed into smaller phosphopeptides that it fully realizes its potential. EcovaPure™ processing makes these changes to phosvitin while preserving the full bioactivity of the peptides.

Small **phosphopeptides**, like the ones in YPP, are known to have excellent DPPH free radical scavenging and antimicrobial abilities, and they can also improve absorption of iron and calcium¹.

For more information on the benefits of [phosvitin phosphopeptides \(PVP\)](#), check out the white papers on our [product page](#). This paper will focus on **the evidence showing YPP has the same bioactive functions as PVP**.

Evidence for Phosvitin Peptides in YPP

Color Test; Developed by Dr. Jack Losso

Ecovatec worked with Dr. Jack Losso, one of the first scientists to investigate phosvitin, to test the properties of phosvitin and YPP. In his lab at Louisiana State University, he created a color change test that would indicate the presence of phosvitin in different egg fractions. This test indicated that our PV and HDL products contain full phosvitin protein and that YPP contains hydrolyzed phosvitin (phosphopeptides).

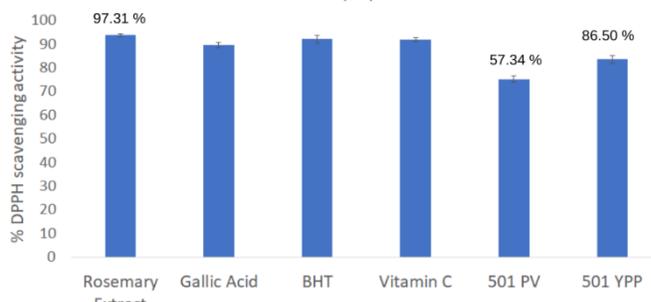
Antioxidant; Nutraceutical, Cosmetic, and Food Industry Applications

According to Lobo, *et al* (2010)⁵, when free radicals such as oxygen and nitrogen, which are generated by the body in its daily functions and systems, build up and are out of balance with available “antioxidants” the body undergoes oxidative stress. Oxidative stress is known to be associated with many diseases.⁵⁻⁸ An antioxidant is any molecule stable enough to bind to a free-radical and neutralize it, thereby delaying or inhibiting cellular damage.⁵⁻⁸ Phosvitin peptides are known to be an excellent antioxidant due to their iron-binding ability.¹⁻⁴

Some of the oxidative stress related disorders include **cardiovascular diseases, carcinogenesis, ageing, neurological disorders** (Alzheimer’s disease, Parkinson’s disease, muscular dystrophy), **inflammatory diseases** (such as arthritis), **diabetes, and many others**.⁵⁻⁸

Oxidative stress can also change the structure of the fats and proteins in the body thereby changing their functions.⁵

DPPH radical scavenging activities of PV and YPP (%)



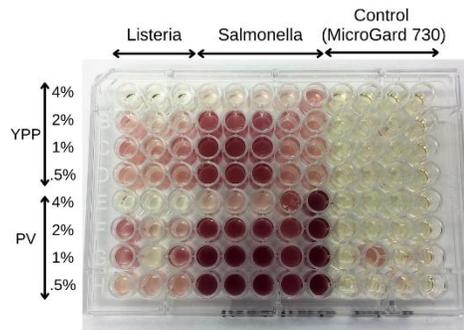
DPPH or 2,2-Diphenyl-1- Picrylhydrazyl is a cell permeable stable free radical that is commonly used to evaluate the ability of compounds to act as free radical scavenger or to measure the antioxidant activity of tissue extracts. EcovaPure PV and YPP were compared against well known good antioxidants for their free radical scavenging activity at 0.5% level. YPP performed better than PV and very well overall.

Dr. Losso tested the free-radical scavenging ability of our phosvitin and YPP. He found that YPP performed well compared to known antioxidants such as rosemary extract and vitamin C.

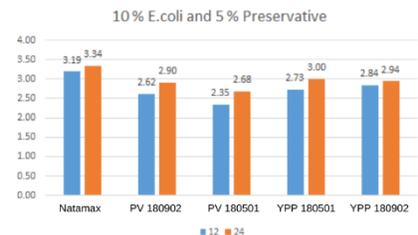
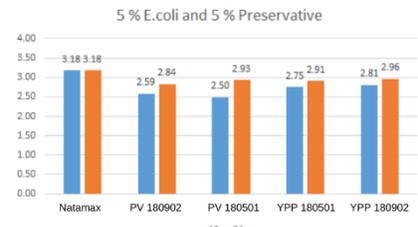
Since YPP outperformed PV and we know that PV is an excellent antioxidant, but that it has higher free radical scavenging activity in peptide form, we can conclude that YPP acts in a similar way as pure PVP due to the presence of PVP in the peptide blend.

Antibacterial; Nutraceutical, Cosmetic, and Food Industry Applications

Dr. Losso also investigated the ability of Ecovatec's phosvitin and YPP to act as preservatives in inhibiting the growth of *E. coli*, *Listeria*, and *Salmonella*. While they do not perform as highly as the standards, they do perform well and YPP performs better than whole phosvitin. This is a clear indicator of the antibacterial activity associated with phosphopeptides.



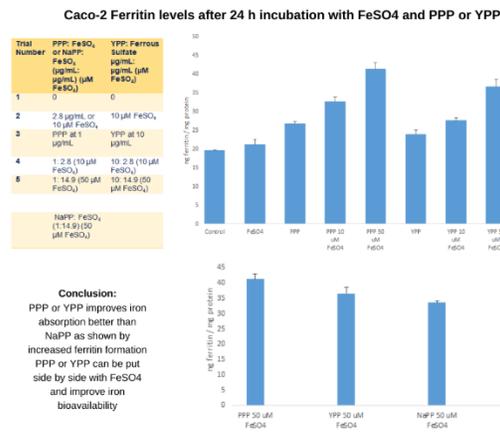
Investigating PV and YPP as antimicrobials against listeria and salmonella, compared to standard Microgard 730. Minimum inhibitory concentration for both products was 4% against listeria and needed higher concentrations for salmonella.



Investigating PV and YPP as antimicrobials against *E. coli*, compared to standard Natamax at 12 and 24 hours. YPP has higher performance than PV, but both less than Natamax.

Iron Absorption Test; Nutraceutical Industry

Ecovatec also partnered with Dr. Losso to do an in-vitro experiment with human intestinal cells to see if adding phosvitin peptides (PPP/PVP) and yolk protein peptides (YPP) would increase ferritin (iron) production in the cells, since phosvitin peptides have been shown by other scientists to increase iron absorption in the gut. In the graph to the right (top), you can see that YPP did act like PVP, though to a lower extent and increased ferritin production compared to the cell alone, or the cell with an iron supplement alone. In the graph below that, you can see that when Dr. Losso compared the ferritin produced by the intestinal cells with PVP or YPP with a known iron absorption enhancer (NaPP), both Ecovatec ingredients outperformed the standard. This again indicates that YPP has similar activity to phosvitin peptides, confirming the presence of PVP in the YPP blend of peptides.



Other Peptides in YPP and their Properties

The lipovitellin derived peptides in YPP also have bioactive functions. Zambrowicz, *et al* (2014)¹ explain how lipovitellin peptides are responsible for egg yolk's anti-adhesive abilities. It also improves the absorption of sialic acid, which is responsible for toxin neutralization, supports brain development, and prevents plaque buildup in arteries.

Specific Research on Blends of Egg Yolk Peptides

Many researchers have studied the properties of egg yolk protein hydrolysates, such as YPP, as an antioxidant and have agreed that they have great potential to be used both internally as a supplement in the body to promote health and reduce oxidative stress and used as a food ingredient to improve the quality and shelf life of food products.^{2,9,10} In particular Sakanaka *et al* (2004, 2006) found that egg yolk protein peptides were an excellent antioxidant in a linoleic acid system (in cookies) and on lipid oxidation in beef and tuna⁹⁻¹⁰.

Young *et al* (2010)¹¹ also investigated the effects of egg yolk peptides on treating and preventing oxidative stress in the intestines, which can lead to chronic intestinal disorders and colon cancer. They used a porcine animal model

(pig) as they have a similar digestive tract to humans and used peroxide to cause the oxidative stress. It was found that the egg yolk peptide supplements exhibited antioxidative stress properties and can be used to reduce intestinal oxidative stress.¹¹

Egg yolk protein peptides have been investigated in live animal models in Japan to determine if they could improve bone density in post-menopausal women.¹² Dogs whose ovaries are surgically removed exhibit the same bone density loss due to hormone changes as do women after menopause. It was found that including egg yolk protein peptides in the diet of these dogs was able to increase bone formation in the dogs in the months following the hormone changes. Further studies need to be done to investigate the effects of the drugs on humans, but these results are promising to improve bone density in patients.¹²

Zambrowicz *et al.* (2015)¹³ also studied the angiotensin converting enzyme (ACE) inhibitory properties of egg yolk peptides, which could have amazing applications in controlling hypertension in patients with high blood pressure.

Commercial Applications

EcovaPure™ YPP has applications in nutraceuticals, cosmetics, and in the food industry. Read our white paper about [the cosmetic applications of egg yolk peptides](#) for some of the specific benefits of YPP in cosmetic formulations. YPP can be formulated into calcium or iron supplements to improve bioavailability of these nutrients or it can be used as an antimicrobial or antioxidant in food preservation applications.

There is currently a competitor blend of egg yolk peptides available for purchase in many parts of Asia. However, these peptides are produced as a byproduct of lecithin extraction through harsh chemical solvents and the proteins are denatured prior to being broken into peptides, changing their form. They also contain fewer phosphopeptides and the bioactivity of all the peptides may be reduced due to the extensive processing.

Contact our sales team at sales@ecovatec.com to learn more about how you can innovate with this revolutionary new ingredient, carefully isolated in a way that preserves the full power and bioactivity of egg yolk peptides.

Sources

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