



carotenoids. So the question is: are any of the rose ketones possibly RXR agonists? It turns out that one very significant rose ketone may indeed be a rexinoid:  $\beta$ -ionone (Liu, et al, 2008). And like bexarotene,  $\beta$ -ionone also happens to inhibit tumor growth and induce apoptosis (programmed cell death) in cancer cells (Janakiram et al, 2008).

In addition to these actions,  $\beta$ -ionone is also an inhibitor of 3-hydroxy-3-methyl-glutaryl-CoA reductase (HMG-CoA reductase) which is the rate-limiting enzyme responsible for production of cholesterol in the liver (Yu et al, 1994). Statin drugs such as lovastatin lower cholesterol by inhibiting this enzyme. In addition to  $\beta$ -ionone several isoprenoid fragrance compounds also modestly inhibit HMG-CoA reductase, such as d-limonene and geraniol (Elson, 1995). d-limonene is found in citrus fruits and has an intense odor of oranges. Geraniol is a major constituent of rose and ylang-ylang oil with a strong rose-like odor. Yu et al (1995) tested  $\beta$ -ionone in an animal tumor model and found it was an effective anticarcinogenic agent. These data support the idea that  $\beta$ -ionone may have a chemoprotective effect against cardiovascular disease and certain forms of cancer (Elson, 1995).

But the main point is that  $\beta$ -ionone, one of the fragrance components of violet flowers, may turn out to have pharmaceutical properties that could be therapeutic for treatment of Alzheimer's disease, not to mention cancer. Whether it fulfills this promise will depend on further investigation. In the meantime, please enjoy fresh roses, violets or add a bit of ginger to your tea.

## References

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