

Potential Human Health Benefits of Dried Distiller's Grains Solubles

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DDGS may have use in human food products

DDGS is a nutritious product for animal feeds

DDGS has components that make it potentially valuable as an ingredient for human foods

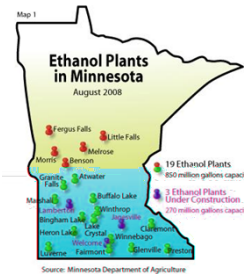
- Polyunsaturated fatty acids
- Antioxidants/phenolic acids
- Dietary fiber
- Xanthophylls

Establishing a human health benefit would greatly increase interest in DDGS for human use



Finding a suitable DDGS product

DDGS samples are processed in somewhat different ways at different plants



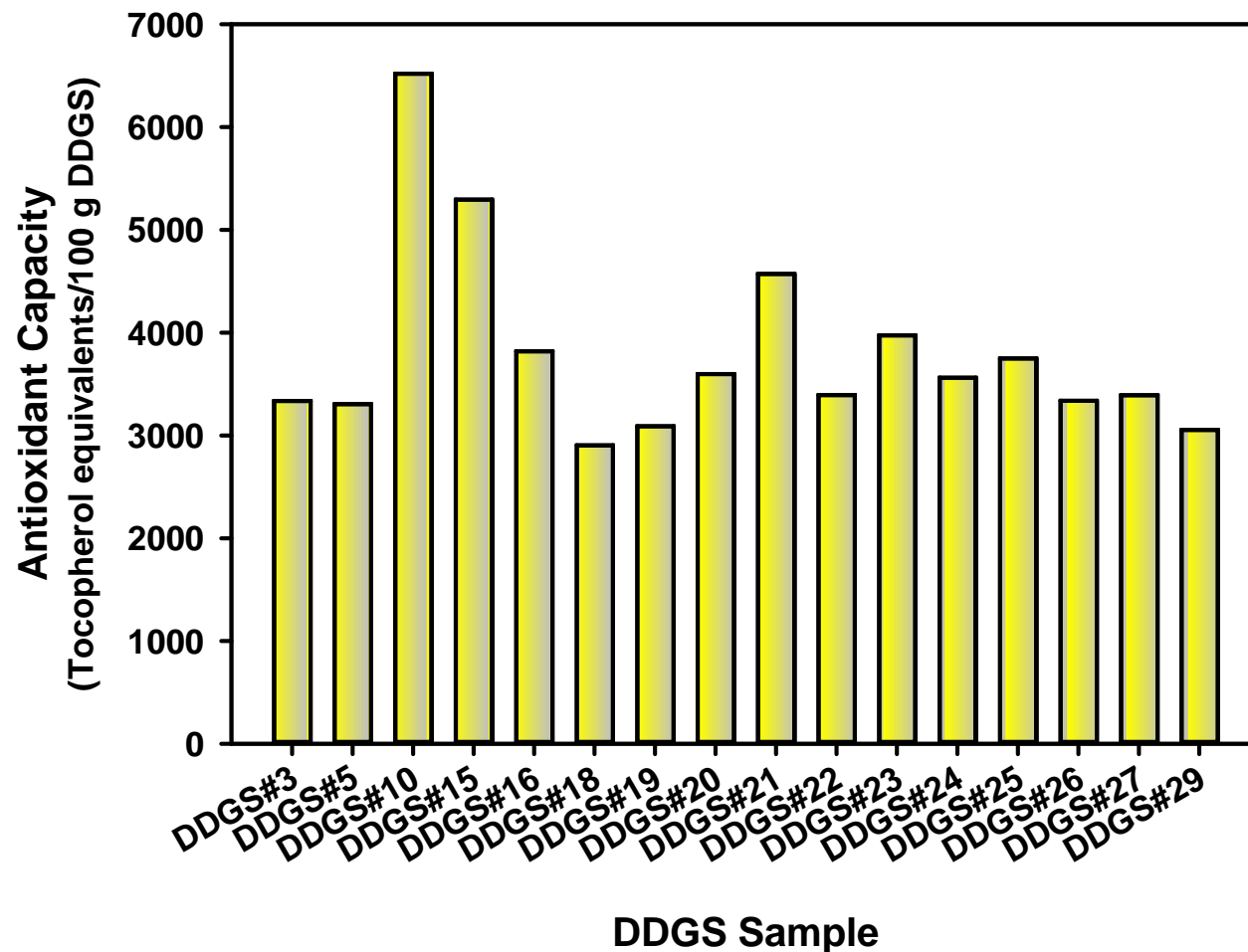
Aggressive drying conditions may damage the product

- Increase fat oxidation
- Reduce antioxidant capacity
- Produce undesirable Maillard reaction products

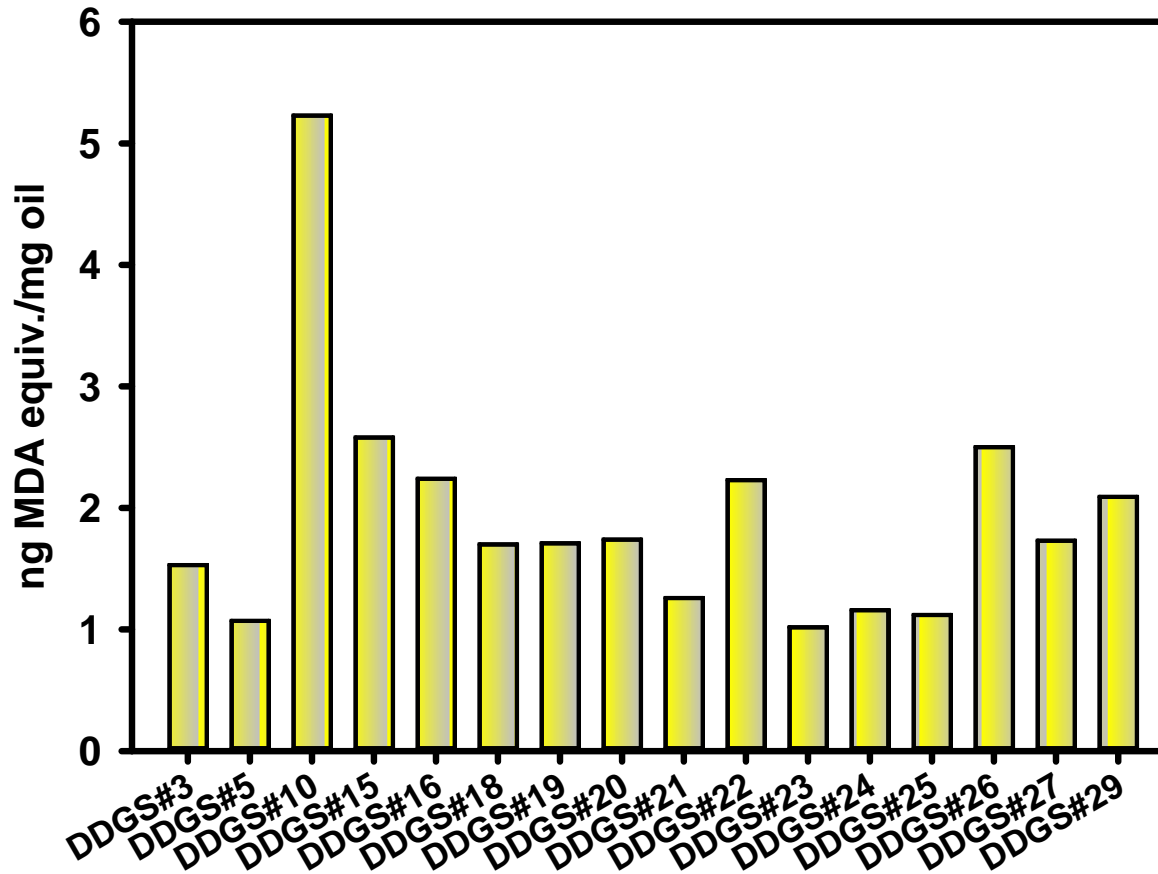
Thus, characterized a number of DDGS samples to find a suitable one for animal studies



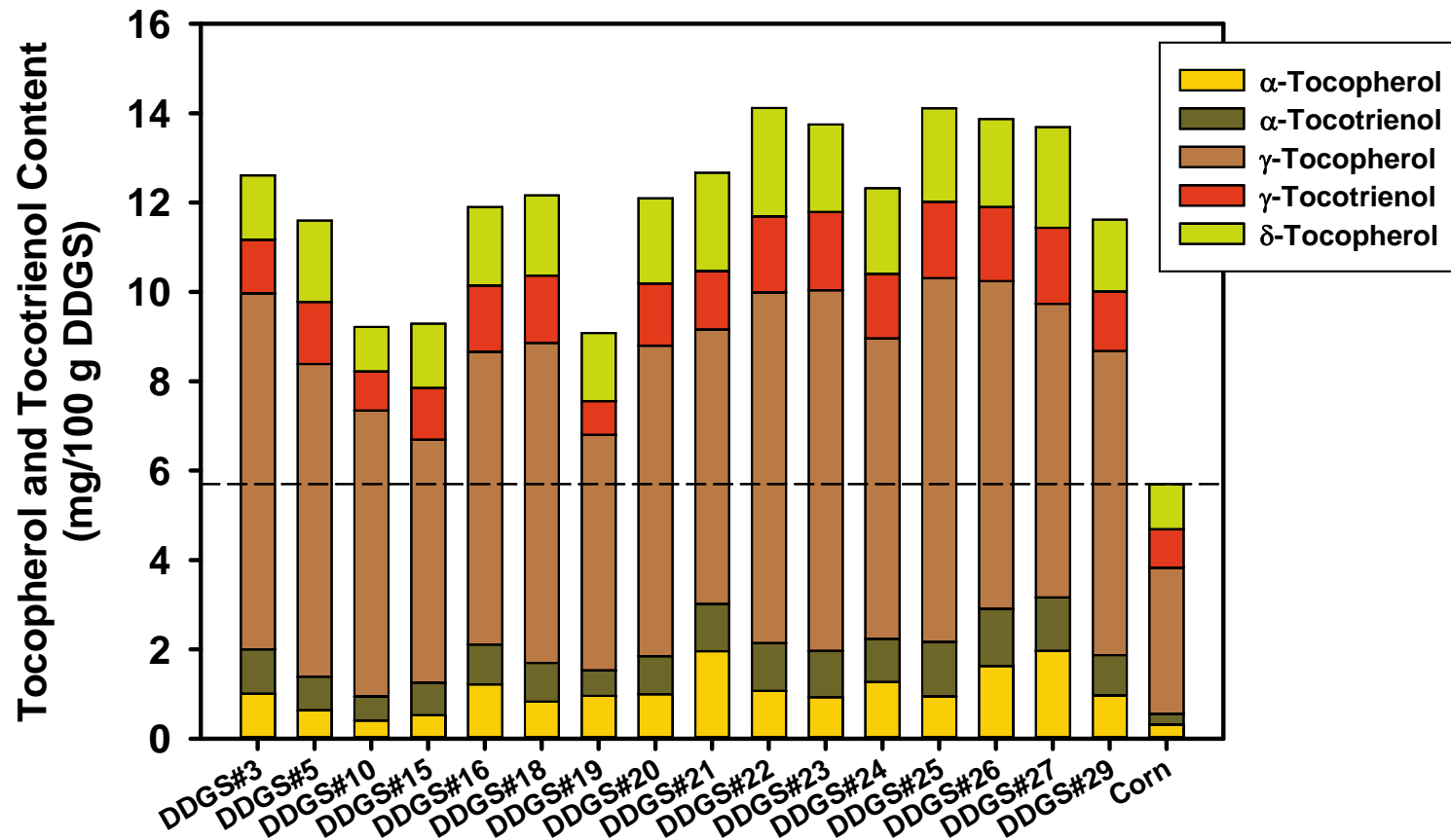
DDGS samples vary in their antioxidant capacity



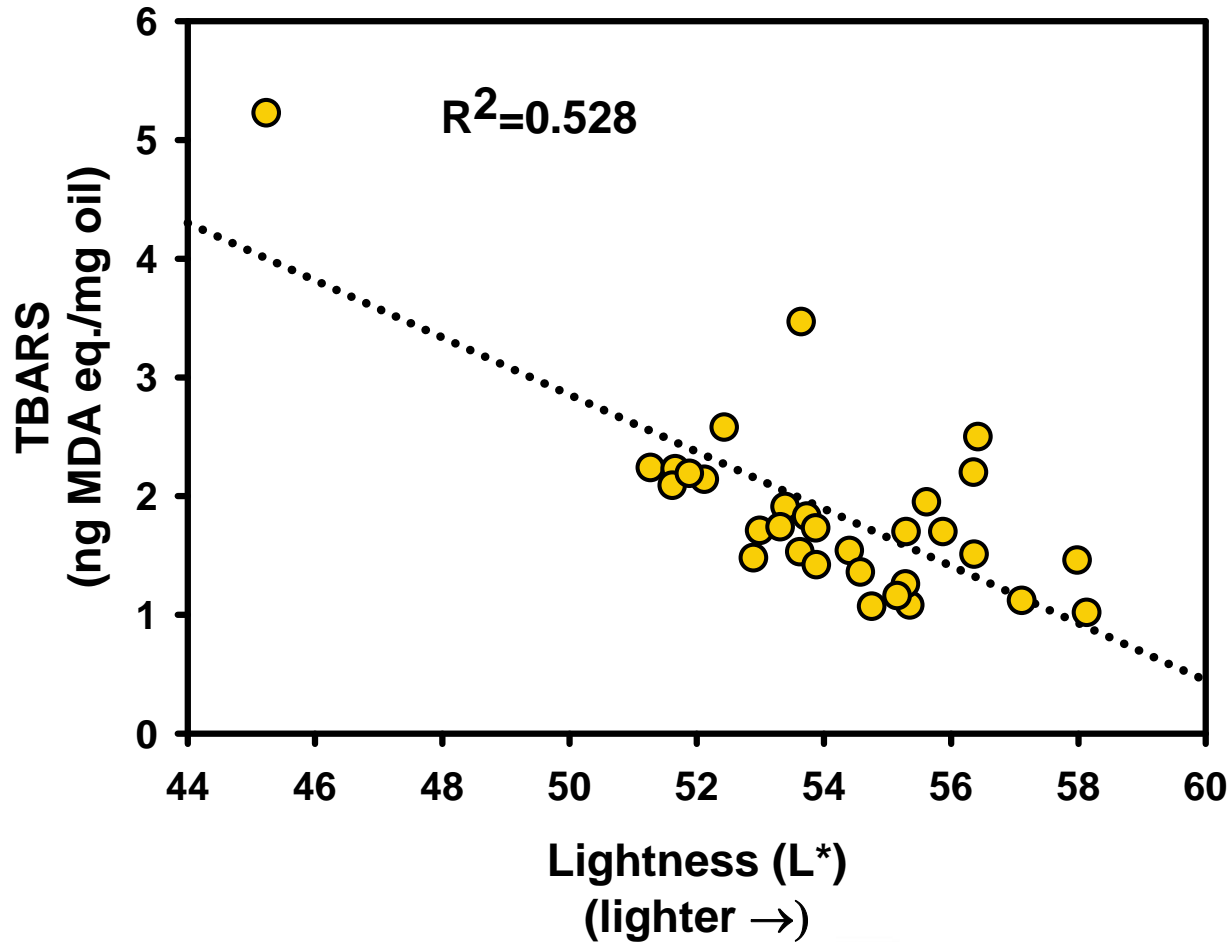
There is great variation in lipid peroxidation of DDGS fat



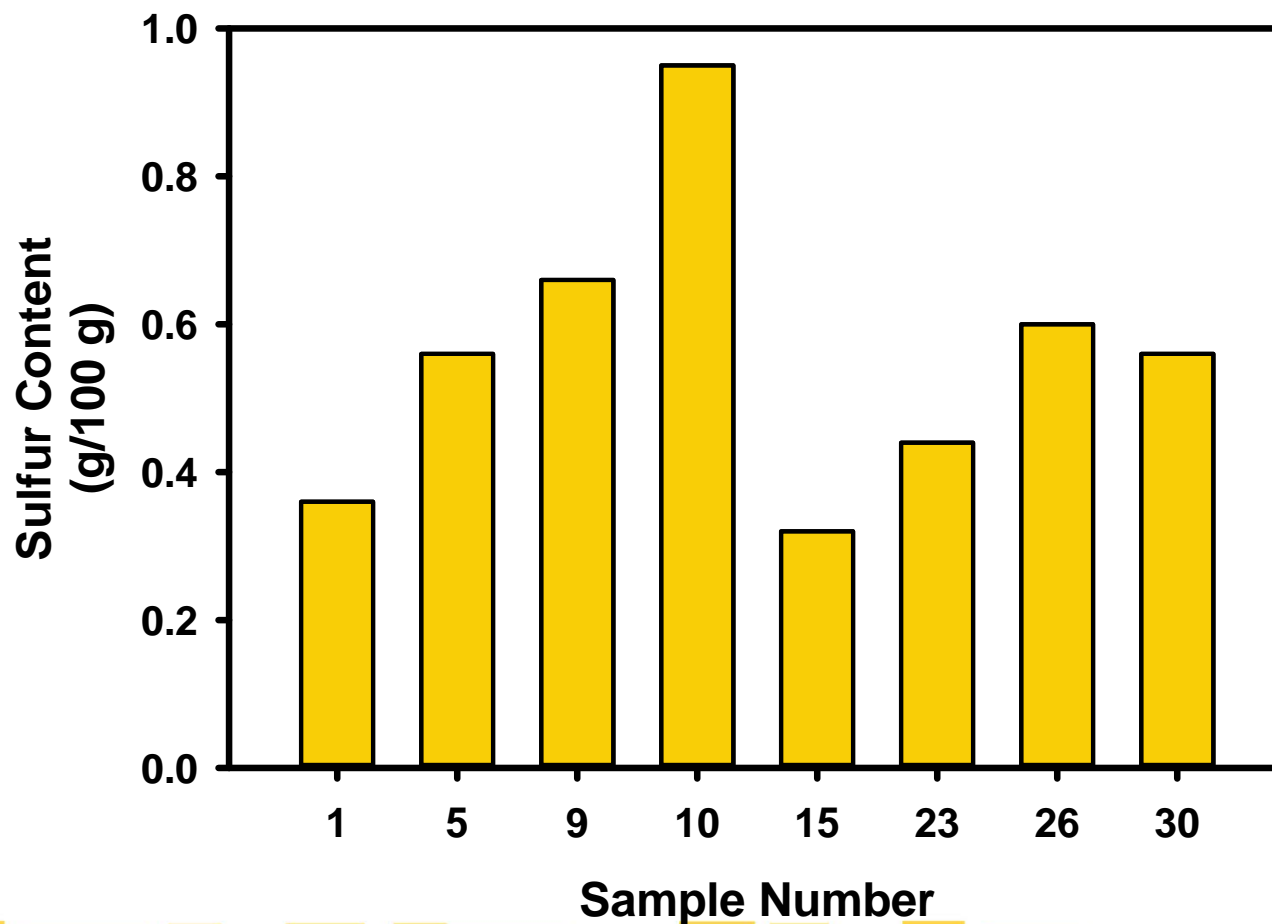
DDGS vitamin E content varies, but is greater than corn



Lightness, a marker for thermal damage, correlates with oxidation



Sulfur content of DDGS is highly variable



Ferulic acid in free (unbound) form may have great health benefits

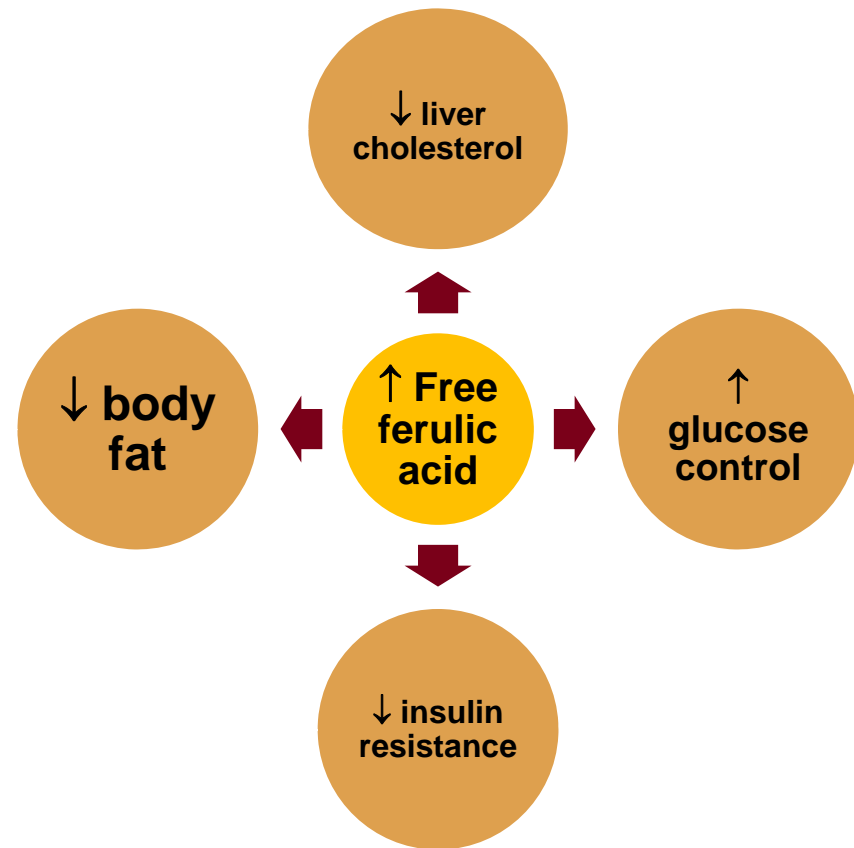


The Zucker diabetic fatty (ZDF) rat

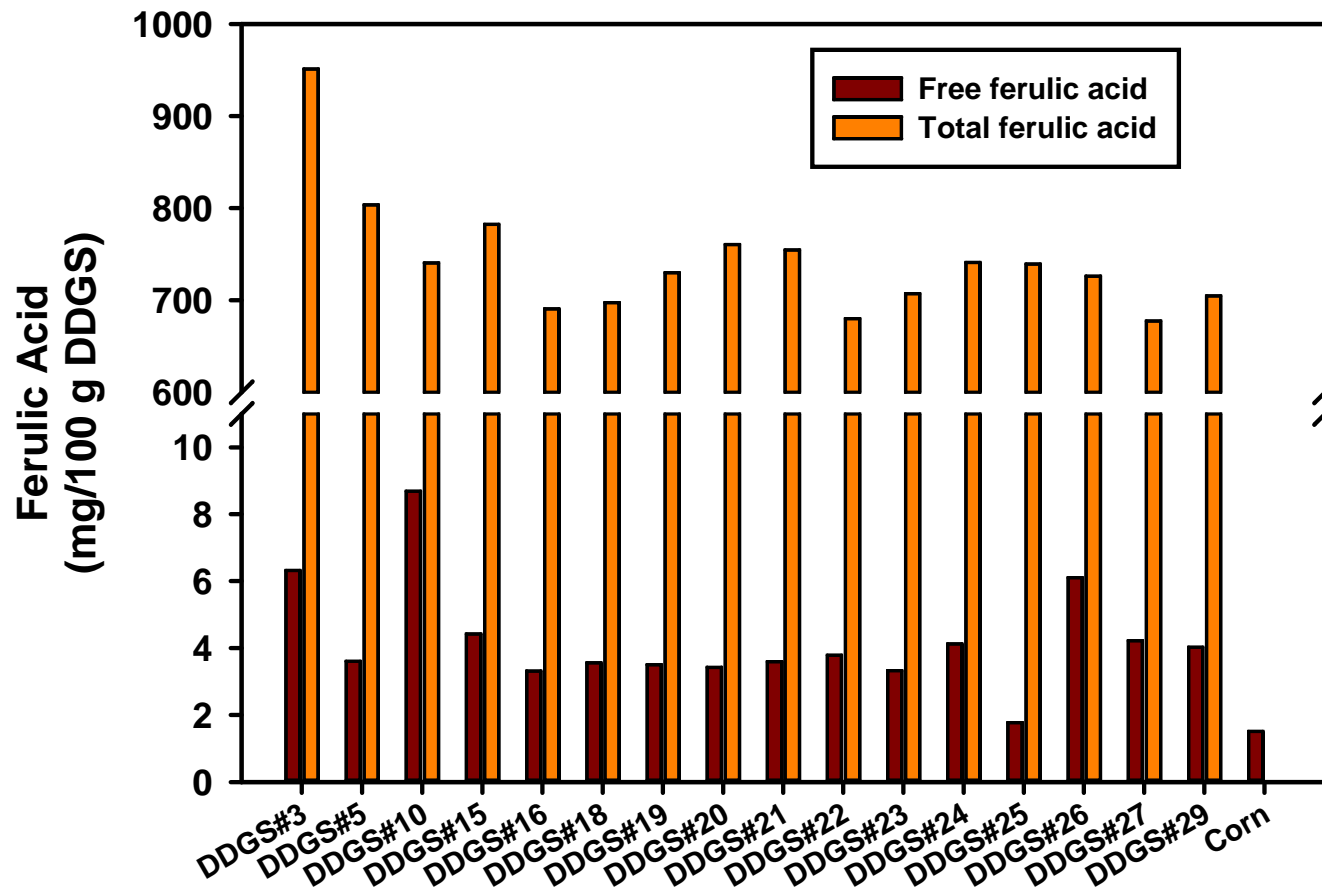
Displays

- ✓ Obesity
- ✓ Hyperglycemia
- ✓ Insulin resistance
- ✓ Hyperlipidemia

Model for metabolic syndrome and type 2 diabetes with obesity

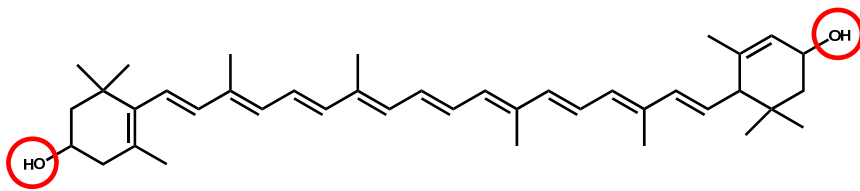


DDGS has a greater concentration of free ferulic acid than corn

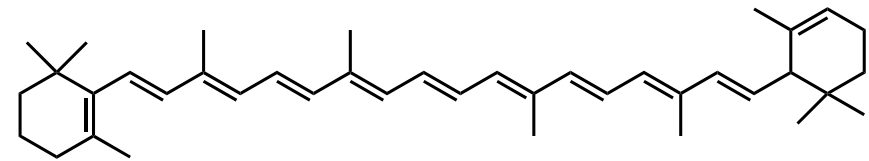


Corn is a rich source of xanthophylls

- Xanthophylls are a type of carotenoid

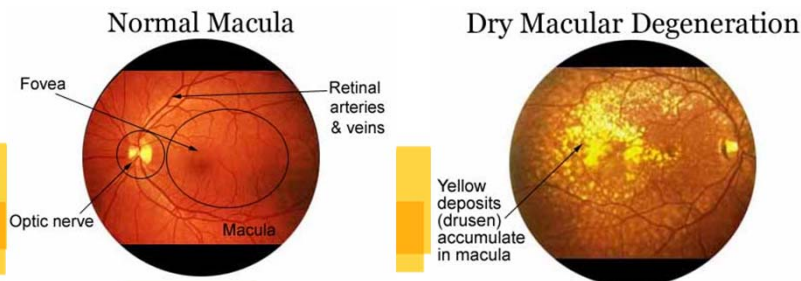


Lutein
A xanthophyll

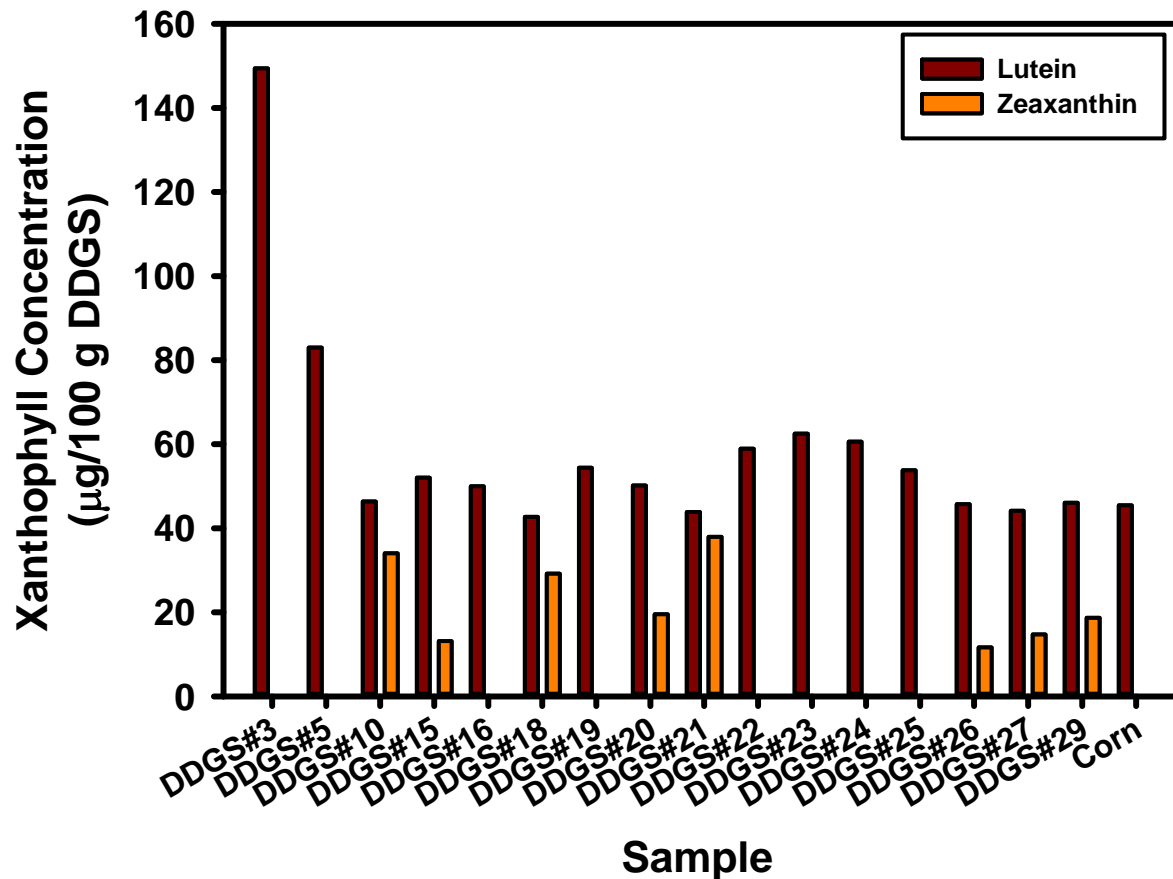


β -carotene

- Potential health benefits include –
 - Decreasing heart disease risk
 - Reducing macular degeneration



The main xanthophyll in all samples was lutein



Objectives of the first animal study

Determine effects of DDGS and other co-products on –

- Liver cholesterol
- Bile acid excretion
- Oxidative stress
- Xanthophyll bioavailability



Diet Groups

Control – purified diet

DDGS - Distiller's Grains with Soluble Residue (20%)

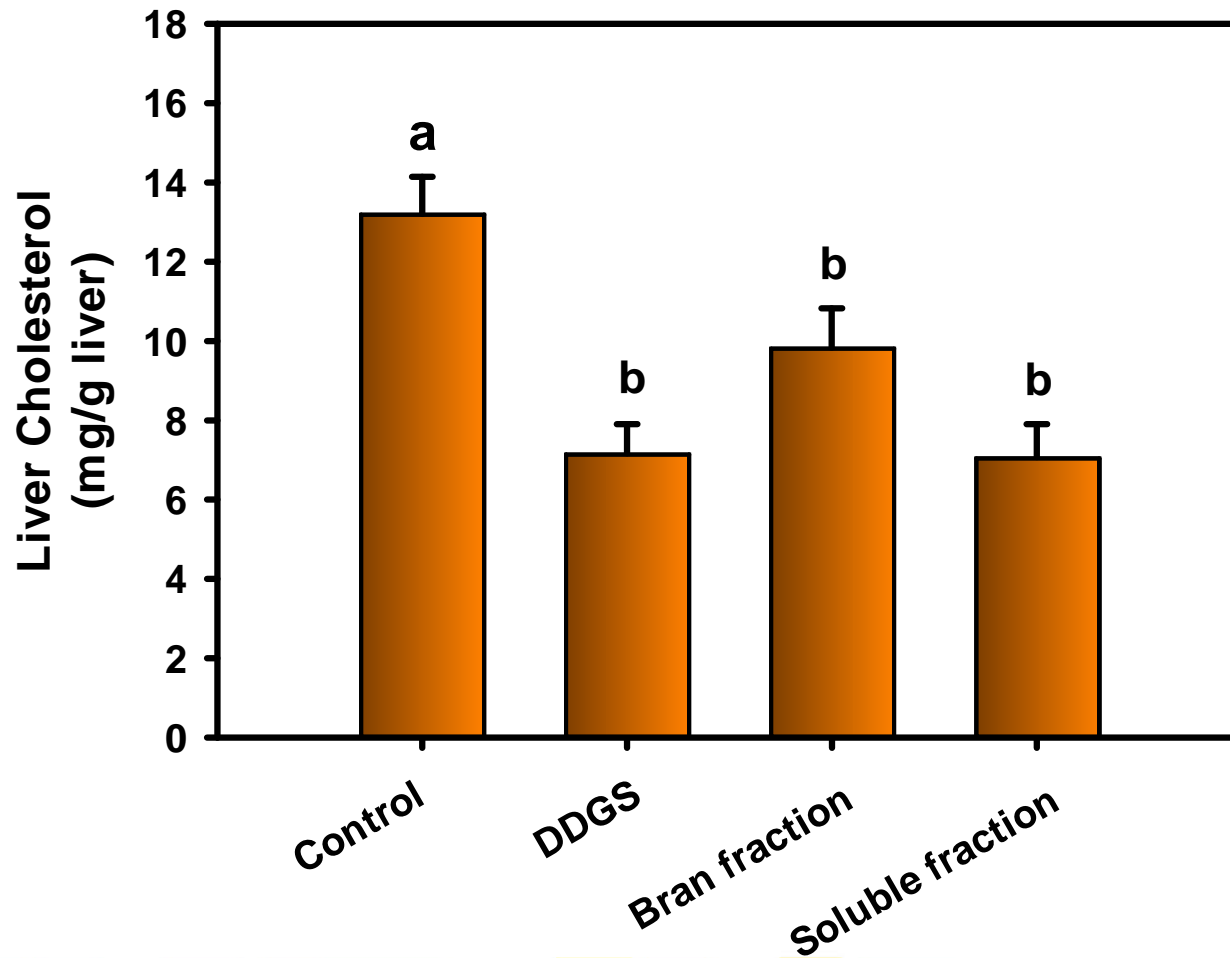
Bran Fraction of Corn (20%)

Soluble fraction - Soluble Residue (20%) (DDS)

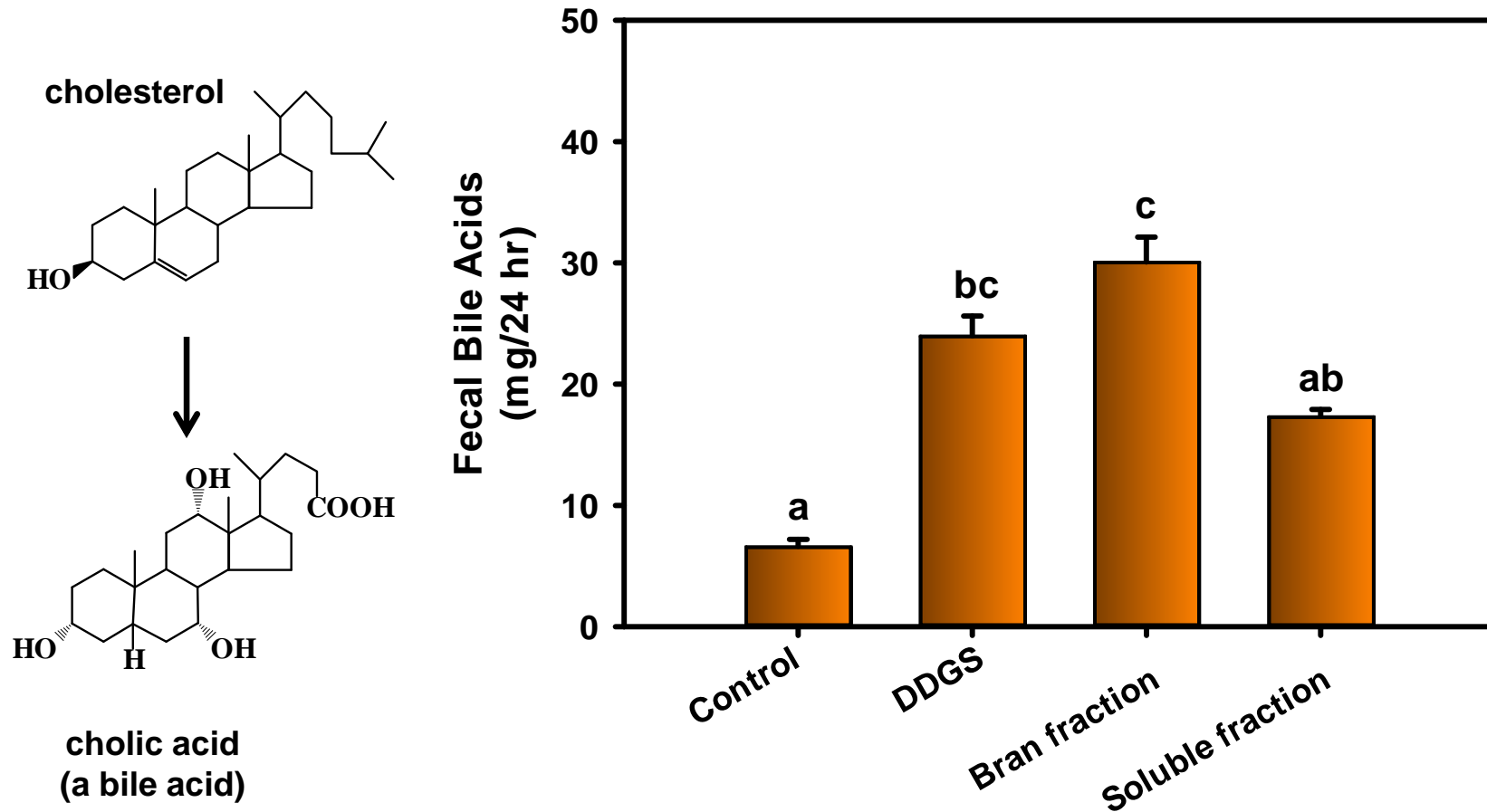
**All diets were
balanced for
protein,
carbohydrate, fat,
and fiber**

- Cholesterol - 0.15%
- Fat - 15%
- Fiber - 9.5%

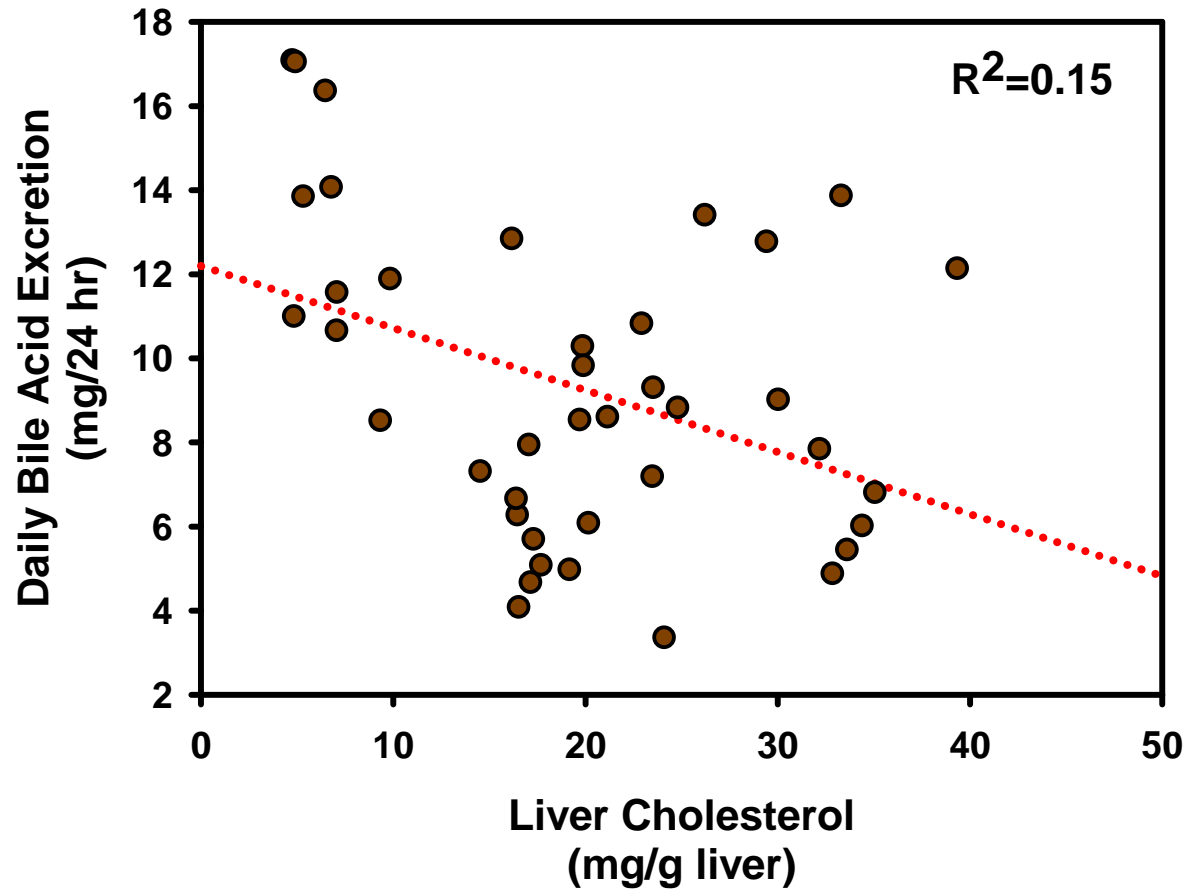
DDGS and co-products reduced liver cholesterol



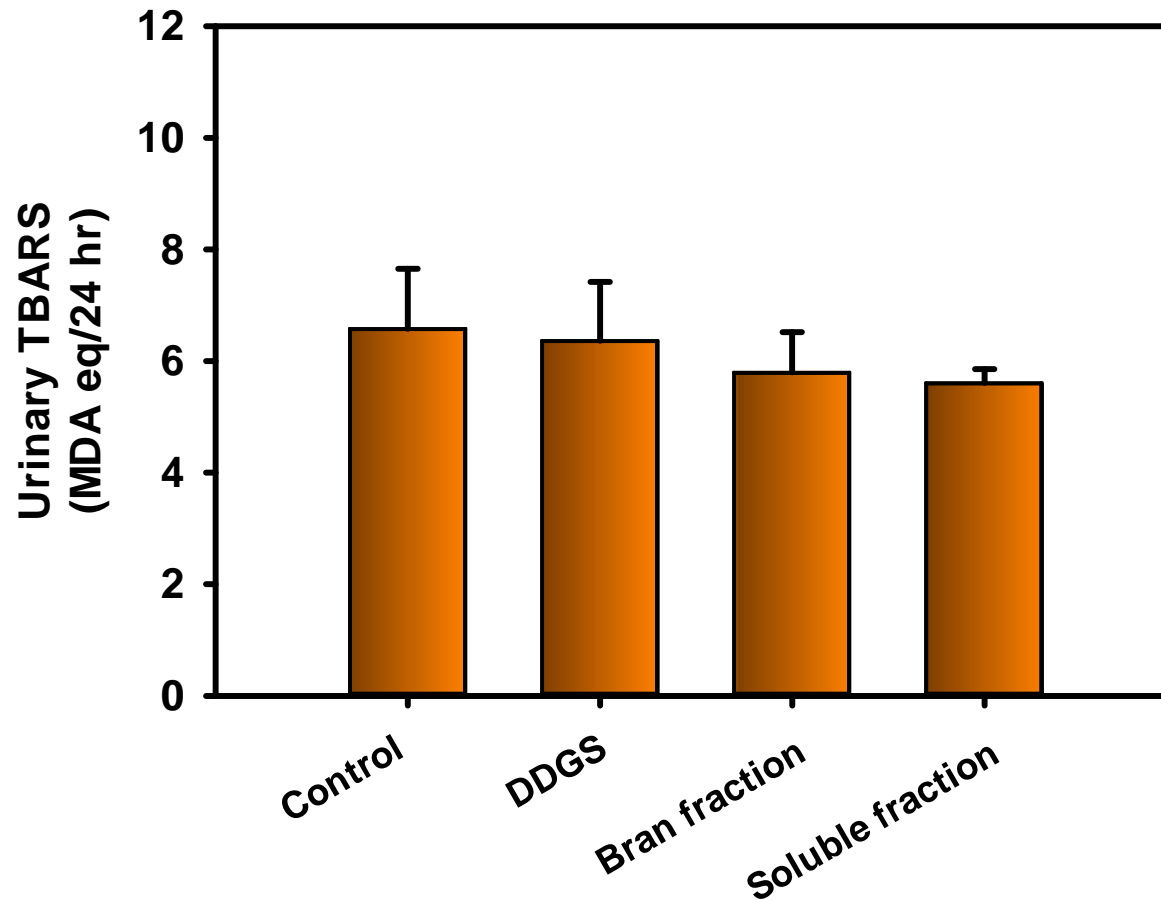
DDGS and co-products increase bile acid excretion



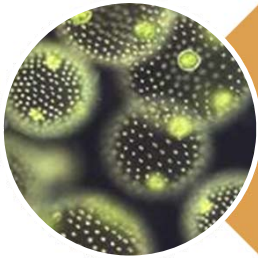
Bile acid excretion does not correlate with liver cholesterol



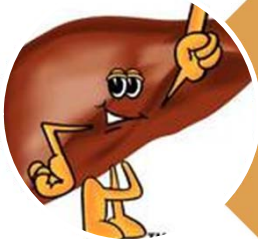
DDGS and co-products did not alter a marker of oxidative stress



Determination of bioavailability of xanthophylls in DDGS and co-products is in progress



Plasma concentrations of xanthophylls in rats fed DDGS is **too low** to detect



Will determine xanthophyll concentration in **tissues** collected at end of feeding trial



Analyze by LC-MS

Objective of the second study

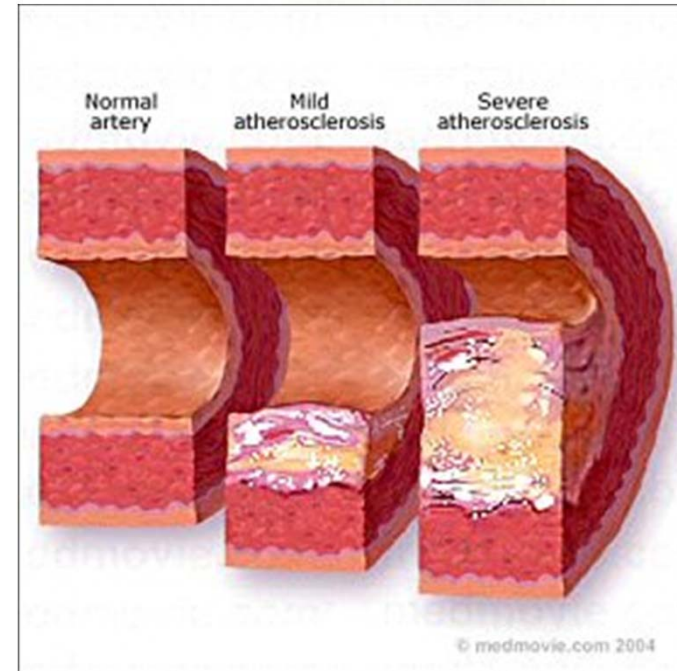
Determine whether DDGS, dried condensed distiller's solubles (DDS), or corn bran would reduce **plasma cholesterol** and **atherosclerosis**

Apo E-deficient knockout mouse – a model of atherosclerosis

Mutation results in a marked increase in total plasma cholesterol levels

Fatty streaks occur in the aorta by around 3 months

Fatty streaks progress to atherosclerotic lesions



Diet Groups

Control – purified diet

Bran Fraction of Corn (20%)

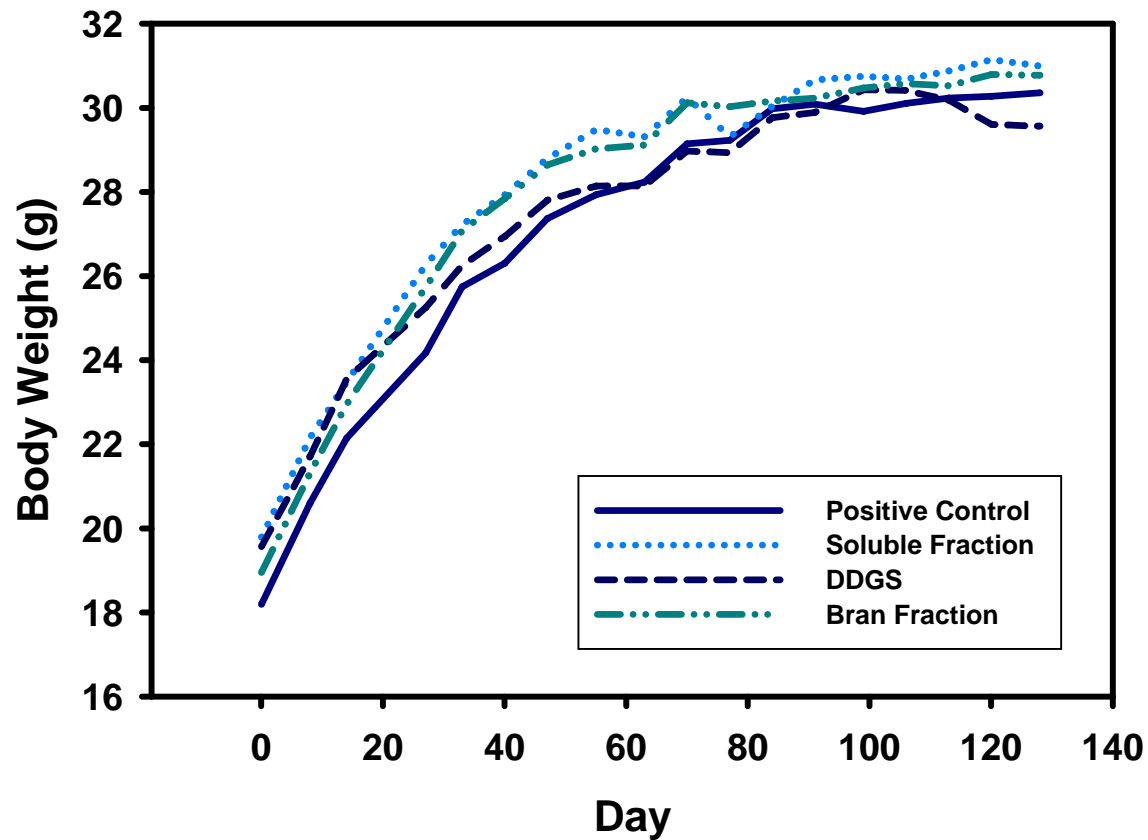
DDGS - Distiller's Grains with Soluble Residue (20%)

Soluble fraction - Soluble Residue (20%) (DDS)

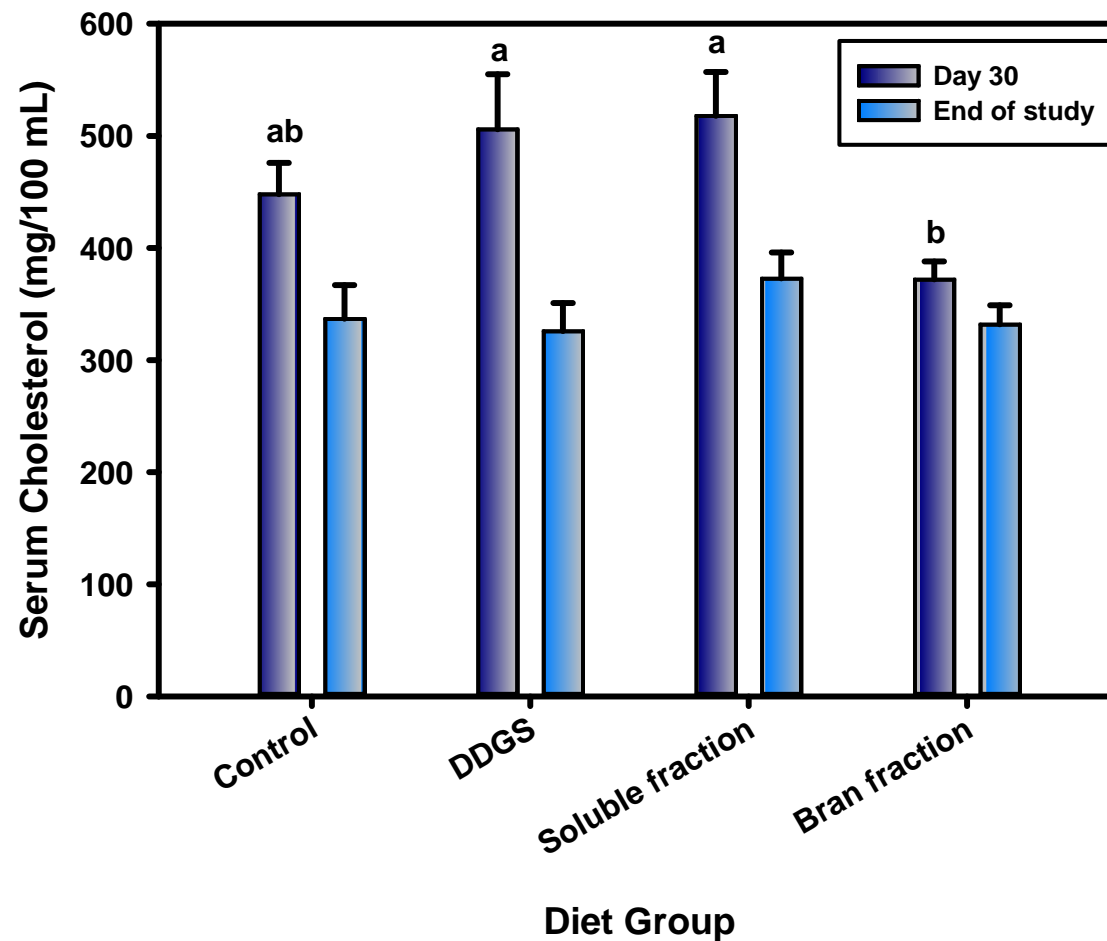
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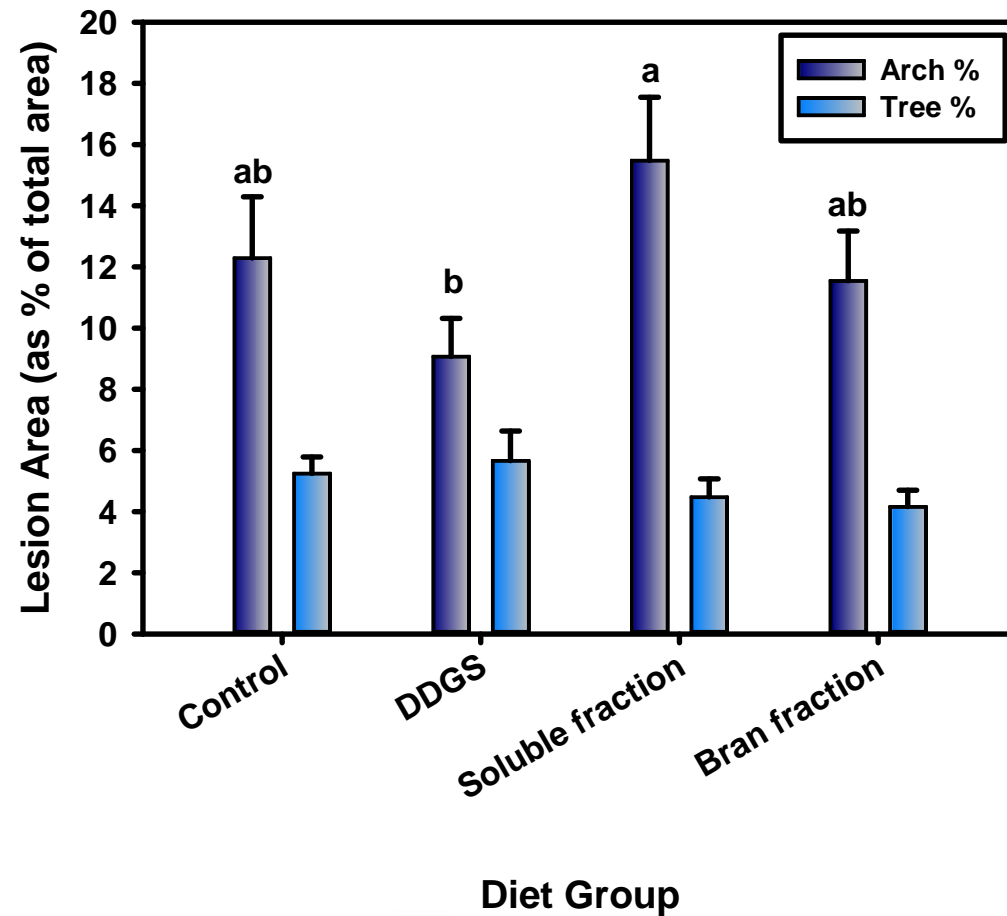
Mice grow normally when fed DDGS or other co-products



Total Serum Cholesterol



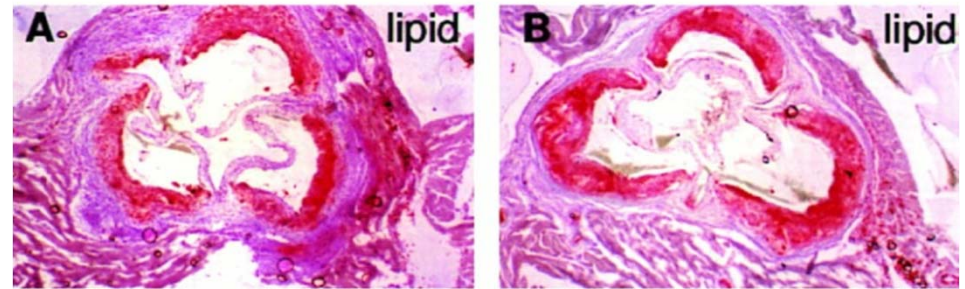
Atherosclerotic lesion area



Atherosclerosis indicated by red stain

In progress - measurement of coronary aortic root

- Determine blockage of aortic root
- Will complement atherosclerosis lesion area



Summary of animal studies

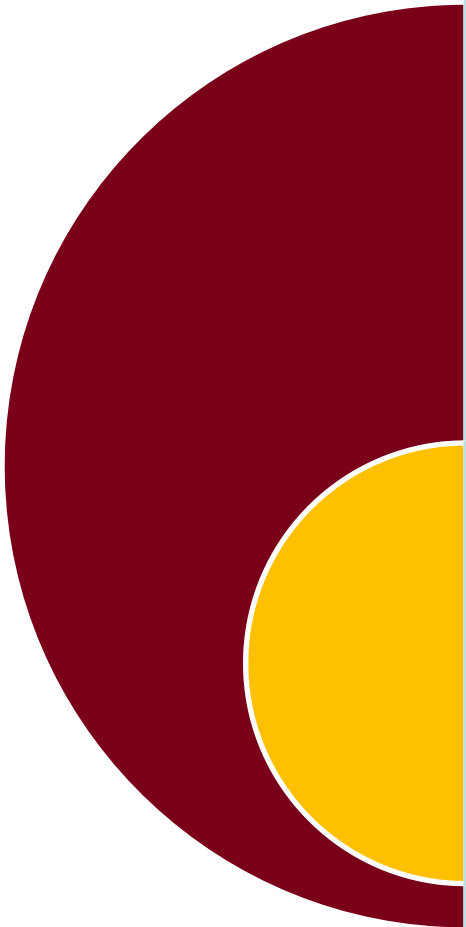
Cholesterol

- In rats, DDGS and co-products lowered liver cholesterol and increased bile acid excretion
- No effect on serum cholesterol in apoE-deficient mice

No effect on one marker of oxidative stress

Trend toward reduction in atherosclerosis lesion area with DDGS

Conclusions



DDGS may have *some* benefit in reducing heart disease risk

If DDGS and other co-products show tissue accumulation of xanthophylls, this will be viewed as a significant health benefit

Acknowledgements



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