THE EFFECT OF DAIRY AND RED MEAT ON METABOLISM AND COLON HEALTH

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ABSTRACT

This thesis describes a series of experiments that aimed to investigate the effects of sairy and red meat on metabolism and colon health. There were four main experimental directions followed.

Effect of fat type and heme on risk markers of colon cancer

Heme iron is a component of red meat that has been shown to effect biomarkers associated with colon cancer risk. It was not clear whether different dietary fat types may interact with heme to influence fecal water cytotoxicity or colon proliferation. Rats were fed diets containing 20% fat as sunflower seed oil (SSO), milk fat (MF), and heme iron was added to these diets at 0, 0.02 and 0.08g/100g. Addition of heme to the SSO based diet increased cecal and fecal water cytotoxicity, colon crypt height, fecal moisture, fat and cation concentration. These differences were not seen for the MF diets. Thiobarbituric acid reactive substances (TBARS) in the fecal and cecal water and urine were positively related to the concentration of heme in the diet, but were not affected by fat type. The increase in fecal and cecal water cytotoxicity for rats consuming the heme and SSO diets, but not heme and MF diets may be due to the types, rather than concentration of lipid peroxides formed from the different dietary fats.

Heme iron: an initiator of colon cancer?

Heme iron together with polyunsaturated fat has been shown to be genotoxic to cells in vitro. It was hypothesized that feeding a high heme/polyunsaturated fat diet to rats would increase the amount of genetic damage in coloocytes. Coloocytes were isolated and then analysed for DNA damage using the Comet assay. Animals fed the heme/polyunsaturated fat diet showed an increase in the amount of genetic damage in the coloocytes isolated from the distal colon, in comparison to animals fed a control diet. If the heme induced genetic damage occurred to specific genes such as APC, DCC, or p53 this may lead to the initiation of cancerous cells. Further investigation is required to determine the role of heme as an initiator of colon cancer.
Dietary protein type and density: effect on colon cancer risk

In the third study, the effect of red meat, whey protein and their density in the diet on aberrant crypt foci (ACF) expression was examined in azoxymethane treated Wistar rats. Increasing red meat density correlated positively with rate of weight gain, while increasing whey protein density correlated negatively. Dietary intake was not affected by protein type or density. The 32% WPC group had significantly less ACF in the proximal colon in comparison to the 16% and 32% red meat groups. This reduction in ACF number in the whey protein group may be caused by hormones associated with the reduction in weight gain, and/or by components of whey protein such as cysteine, lactose and conjugated linoleic acid. These components have been shown to have anti-cancer effects. When using ACF number as a marker of colon cancer risk, whey protein appeared to be more protective than red meat. Increasing the density of red meat in the diet did not increase ACF expression.

Dietary protein type and density: effect on metabolism

Studies in growing rats have shown that red meat may increase weight gain whereas whey protein may reduce weight gain. It was hypothesized that in mature insulin resistant Wistar rats, increasing the density of whey protein, but not red meat, would reduce weight gain, body fat storage and improve insulin sensitivity. The high protein diets reduced energy intake, visceral, subcutaneous and carcass fat and increased carcass protein. The high protein diets also lowered fasting plasma triglyceride and IGF-1. Increasing the density of whey protein, but not red meat in the diet was associated with a reduction in body weight gain. This is supported by a reduction in plasma insulin and improved insulin sensitivity for the high whey protein group. These findings support the conclusion that the high protein diet was effective in reducing energy intake and adiposity and that WPC was more effective than red meat in reducing body weight gain and improving insulin sensitivity.
Summary

The heme iron content of red meat has been proposed as a possible way that red meat may increase colon cancer risk. In this thesis it was shown that a high heme iron diet in the presence of polyunsaturated fat but not saturated fat (AMF) increased colorectal cancer risk by increasing the cytotoxicity and genotoxicity of fecal water. However, when a high red meat and polyunsaturated fat diet was fed to rats it did not increase ACF expression in comparison to a low red meat diet. The lack of an effect may be due the increased absorption of heme from red meat which leaves insufficient heme in the colon to increase colon cancer risk. This research suggests that heme iron in a high red meat diet is not likely to be a contributing factor to increase colon cancer risk.

In comparison to red meat, whey protein may be an alternative protein source that could be incorporated into the diet to protect against colon cancer risk. The high whey protein fed animals had significantly less ACF in the proximal colon in comparison to the moderate and high red meat fed animals. A possible mechanism whereby whey protein may inhibit colon carcinogenesis is by improving insulin sensitivity through reducing weight gain and body fat deposition. The added benefit of whey protein is that it may be an effective dietary factor to assist reducing the risk of NIDDM, insulin resistance or obesity. In addition, whey protein may also improve disease management for individuals who have either one or more of the conditions.