Grower Summary

FV 420

Carrot and Parsnip: intervention studies to assess the effect of consumption on biomarkers of human health

Final 2017

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Location of project:	Newcastle University
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GROWER SUMMARY

Headline

- Carrot, parsnips and celery are good sources of compounds known as polyacetylenes, with cooked carrot being the most common source of intake.
- The polyacetylenes can be detected in blood after consumption.
- Eating a moderate amount of carrot (100g) every day can reduce a blood marker of inflammation.

Background

Nutritional factors have been shown to affect the risk of cancer. It is well known that the a higher intake of fruit and vegetables leads to a lower cancer risk and there is increasing evidence that certain fruit and vegetable groups have a protective effect against particular cancers. It is thought that the fibre, antioxidant, vitamin and mineral content of fruit and vegetables are the main factors that contribute to the anti-cancer effect, but current evidence has shown that these common constituents alone cannot explain the effect. Observational studies have found carrot consumption can lead to a lower incidence of cancer (Boggs *et al.*, 2010; Larsson *et al.*, 2010) and there is evidence from studies with isolated cells that suggests the polyacetylene (PA) class of compounds, first investigated in herbal medicines such as ginseng, but also found in root vegetables including carrots, have anti-cancer (Zidorn *et al.*, 2005a) and anti-inflammatory properties (Alanko *et al.*, 1994). Animal studies have shown a 20% reduction in levels of intestinal cancer when diets are supplemented with carrot (Kobaek-Larsen *et al.*, 2005; Saleh *et al.*, 2013). However, so far, there have been no studies into the health effects of PA intake in humans. The objective of the present study is to determine if consuming a portion of carrots can affect the biomarkers of cancer and inflammation in humans by examining:

1. The PA content of commonly eaten foods in a population from the North East of England and if there is any association between eating polyacetylene-rich foods and cancer incidence.
2. The effect of cooking techniques on PA concentration in carrots.
3. The bioavailability (how much is digested and absorbed) of PA from cooked carrots and how much PA can be detected in the blood, urine and faeces after consumption by humans.

4. The effect of a diet supplemented with carrots on biomarkers of cancer risk in humans (dietary intervention study).

Summary

Objective 1: Creating a database of polyacetylene-containing foods

The database of foods has been compiled which contains the PA content of foods commonly eaten in a population in North East England. This database will allow the public to make choices about how they consume vegetables (fresh, cooked) and in what form (fresh, frozen, as part of a mixed ready meal, as part of a mixed home-made dish) to give them the greatest intake of PA. A total of 19 different foods, were analysed and combined with values from previously published literature to complete the database. From the database, the highest concentrations of total PA were found in celery but the individual compounds of falcarinol, falcarindiol and falcarindiol-3-acetate were found in boiled parsnip (54.9mg/Kg), raw celery (37.1mg/Kg) and boiled carrot (16.5mg/Kg) respectively. The lowest amounts were found in mixed meals as they are made of multiple ingredients. However, once portion size was taken into consideration, a portion of some mixed meals and soups contained similar amounts of PA to a portion of whole vegetables. Considering also how often the foods were eaten, by far the most important source of PA in this group was boiled carrot (0.50mg/day). Estimated daily intake of total PA in the Newcastle 85+ population was 1.37mg/day.

The database was used to estimate the intake of PA in each participant in the Newcastle 85+ population. The dietary intake data from this trial was unsuitable for accurately measuring the differences in intake between individuals and thus measure whether there is an association between carrot intake and cancer incidence. The data has been sent to a collaborator who can use the polyacetylene database with data that has more accurate dietary intake as well as being a much larger dataset with many more individuals.

The database will be made available to other researchers to allow them to estimate the intake of PA in their study populations and to assess associations between consumption and incidence of diseases. These results were shown at the Nutrition Society Summer conference, July 2016.

Objective 2: To determine how the preparation and cooking of carrots in a domestic setting can affect the concentration of PA

Carrots have been prepared as either disks, quarters or whole then boiled and fried for different amounts of time.

The overall results are summarised below:

The amount of polyacetylene retained in boiled and fried carrots is similar.

Higher amounts of polyacetylene are seen in oil than in water.

Carrots cooked whole retain more polyacetylene (approx. 85-100%) than those cut into disks or quarters (approx. 50-75%).

The recommendation would be to cook the carrots whole rather than in disks or quarters for the best retention of PA.

These results were shown at the HDC student conference 2015, Onion and Carrot Conference in November 2015, and the Nutrition Society Spring Conference, March 2016.

Results from this section were used to decide how to prepare the carrots for the participants involved in the human trials.

Objective 3: To determine the bioavailability of PA from carrots – are the compounds seen in the body after eating?

The bioavailability trial recruited 6 healthy adults, aged between 18 and 30 years old. They provided urine and stool samples and a fasting blood sample before consuming a breakfast of carrots and bread and butter. They had blood samples taken up to 24 hours and provided further urine and stool samples up to 48 hours. The volunteers took part on 2 separate days, consuming different ‘doses’ of carrot on each day (100 or 250g).

Analysis of the blood samples shows that falcarinol and falcarindiol-3-acetate can be detected in the blood after consumption of a portion of carrots. There was no difference in response between portion sizes so a moderate intake of carrots (100g) is sufficient to increase the levels of the compounds in the blood with no benefit of eating larger portions.

There was not enough time to develop methods to detect PA in stool and urine samples.

Objective 4: To determine the effect of supplementing the diet with white carrots on inflammation and DNA damage

This study recruited 39 healthy adults, aged over 45 years old. Each participant was randomised to eat either 100g white carrots plus 10g butter, or 3 oat cakes per day for 6 weeks. This was then followed by a 6-week ‘wash-out’ period where no carrots or oats were eaten (all other carrots, oat products and PA containing foods were also forbidden during the full 12-week period). Participants provided urine and stool samples at baseline, 6 and 12 weeks, and fasted blood samples were also taken at these time points. The samples were analysed for inflammation and DNA damage in the lymphocytes (white blood cells which can be used to assess the overall damage that our bodies experience on a day to day basis).

Results of this trial showed that consumption of a moderate amount of carrot could reduce the level of one of the measured blood markers of inflammation but with no significant change in DNA damage, after consumption every day for 6 weeks, in comparison to baseline and a control (oats).

Financial Benefits

The promotion of the health benefits of carrots, parsnips and other Apiaceae vegetable consumption could lead to a significant and sustained sales increase. Press releases will advertise the findings to the public when key papers are published. Peer-reviewed scientific publications are required by EFSA (European Food Standards Agency) to substantiate the health claims of a food. This study aims to generate such publications.

Action Points

None.