



Grower Summary

FV 420

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

Annual 2016

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

Project number: FV 420

Project leader: Dr Kirsten Brandt, Newcastle University

Report: Annual Report, September 2016

Previous report: Annual Report, August 2015

Key staff: Sarah Warner (PhD Student)

Location of project: Newcastle University

Industry Representative: Martin Evans, FreshGro

Date project commenced: 30th November 2013

Date project completed March 2017

(or expected completion date):

GROWER SUMMARY

Headlines

- Literature searches found the major sources of polyacetylenes were in whole vegetables of carrot, celery and parsnip.
- Carrots cooked whole retain more polyacetylenes than those cut into disks or quarters and boiling time has little effect on retention.

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.*, 2005) and anti-inflammatory properties (Alanko *et al.*, 1994). Animal studies have shown reduced 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 in people over 85 years old.
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

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. 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 disease state. A total of 17 different foods, with 124 independent samples were analysed (replicates from different supermarkets) 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 (4.5mg/100g), raw celery (12.6mg/100g) and boiled carrot (1.6mg/100g) respectively. The lowest amounts were found in mixed meals as they are made of multiple ingredients. However, once portion size was taken into consideration, mixed meals achieved similar concentrations to some of the whole vegetables. Considering also how often the foods were eaten, by far the most important source of PA in this group was boiled carrot (0.631mg/day). Estimated daily intake of total PA in the Newcastle 85+ population was 1.03mg/day.

The data for cancer incidence from the cohort has been compiled and analysed to see if there are any associations between polyacetylene-rich food consumption and risk of cancer. Current analysis shows no association between polyacetylene-rich vegetable consumption and risk of cancer. The small sample size in this cohort may be the reason for the lack of association. Studies of this kind are usually performed on cohorts of tens or even hundreds of thousands of people, compared to the <800 people in this cohort, the likelihood of seeing an association was very small.

These results were shown at the Nutrition Society Summer conference, July 2016.

Preparation and cooking of carrots

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

At present we are unable to report the full results of the study as the PhD student aims to publish these first but the overall results are summarised below:

- boiling carrots retains more PA than frying them
- PA are more stable in oil than in water
- carrots cooked whole retain more PA than those cut into disks or quarters

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.

In vitro digestion, used to make an estimation of how much polyacetylene was available during digestion, has proved difficult to get useful results due to large variabilities in polyacetylene content in the digested matter. This experiment may be revisited in the 3rd year of the PhD if time permits.

Bioavailability of PA from carrots

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). The last participant in the trial finished at the beginning of September 2016 and samples are being stored prior to analysis. A method is currently being developed to detect PA in biological samples. The analysis will allow us to determine where PA goes in the body: whether it remains in the gut or whether it is digested and absorbed by the body and detectible in the blood and urine. We can use this information to see if the concentrations that have been used in cell experiments to reduce inflammation and treat cancer cells, can also be seen in the body and therefore whether eating a normal amount of carrot could feasibly be affecting these biomarkers in humans.

Effect of supplementing the diet with carrots

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. These samples will be analysed for inflammatory markers in blood and urine and cell damage in lymphocytes (white blood cells which can be used to assess the overall damage that our bodies experience on a day to day basis). The final participant finished the trial at the beginning of September and analysis of the biofluids is ongoing and predicted to be finished mid-October 2016.

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. 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