

IRISH PHYTOCHEMICAL FOOD NETWORK:- tracing phytochemicals from farm to fork

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In March 2008, the Irish Department of Agriculture, Fisheries and Food agreed to fund the creation of a phytochemical research network of Irish experts (FIRM Ref. Num. 06/NITARFC6). The main objective of the network is to collate scientific expertise on phytochemicals (plant bioactive compounds) found in Irish grown fruits and vegetables (<http://www.ipfn.ie/>). The creation of this network resulted in a collation of existing knowledge and the generation of new information, thus ensuring that maximum benefit is derived from the collective expertise. In addition, the Network model provides the opportunity to get the most out of available resources particularly through a reduction in unnecessary duplication, identification of knowledge gaps, less fragmentation of activities, and greater cooperation and collaboration. Many factors have been shown to affect phytochemical levels in foods. To date the mechanism of action, stability during food processing, effect of agricultural factors, and stability in post harvest storage on these compounds is not well understood. Therefore, there is a need to assemble existing knowledge and provide holistic information on the fate of these compounds up to their site of action.

Phytochemicals can occur in many sorts of plants, and are common constituents of fruits and vegetables that are part of the human diet. Numerous studies suggest that phytochemicals can be responsible for

considerable health benefits to humans such as reduction of the risk of developing many forms of cancer (lung, prostate, pancreas, bladder and breast) and cardiovascular diseases, and/or other benefits such as anti-inflammatory properties. The new research will examine the influence of agronomic factors (e.g. soil type, seasonal variation...), processing and storage on levels of phytochemicals in selected vegetables. In addition, the initiative will focus on developing an understanding of consumer attitudes to phytochemicals.

According to data from the **Food and Agriculture Organization** of the United Nations (FAO, www.fao.org), members of the (a) *Brassicaceae* family e.g., cabbage, cauliflower, broccoli (b) *Apicaceae* e.g., carrots and parsnips and (c) *Allium* family are, after potato, the main crops produced in Ireland (Figure 1). Brassicas with a production

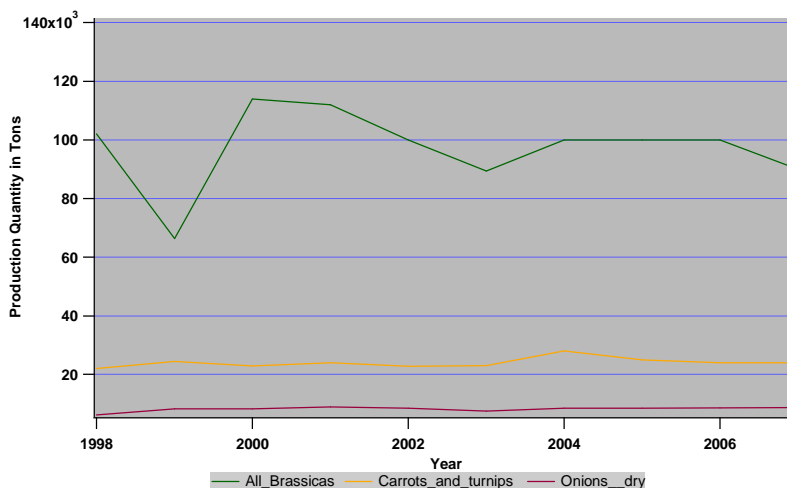


Figure 1: Quantity (tons) of brassicas, carrots, turnips and onions produced in Ireland since 1998 to 2009 (Data source: FAOSTAT, online database of the statistics division of the Food and Agriculture Organization of the United Nations: <http://faostat.fao.org>).

around 100,000 tons/year are at the top of the production ranking in Ireland, followed by carrots with a production of over 20,000 tons/year and finally onions with an annual production of around 10,000 tons/year (Figure 1).

Therefore, the Irish phytochemical food Network is initially focused on three groups of phytochemicals in three main Irish grown vegetables. These phytochemicals are:

Polyacetylenes

Polyacetylenes are examples of bioactive secondary metabolites that were previously considered undesirable in plant foods due to their toxicant properties (1). However, a low daily intake of these “toxins” may be an important factor in the search for an explanation of the beneficial effects of fruit and vegetables on human health. For example, polyacetylenes isolated from carrots have been found to be highly cytotoxic against numerous cancer cell lines (2). Over 1400 different polyacetylenes and related compounds have been isolated from higher plants. Falcarinol, a polyacetylene with anti-cancer properties, is commonly found in the *Apiaceae*, *Araliaceae* and *Asteraceae* plant families (2):

Polyphenols

Polyphenols are a class of compounds characterized by the presence of one or more phenol unit, or building block, per molecule. Polyphenols are a widely investigated and diverse range of compounds. While numerous *in-vitro* studies have demonstrated that polyphenols have potential health promoting benefits, their biological mechanism of action and efficacy in human dietary intervention studies is as yet

unknown. However, their biological mode of action is most likely related to their ability to scavenge harmful free radicals (3). Reactive oxygen species (ROS) generated during oxidative stress can react readily with bio-molecules (DNA, RNA, proteins...) damaging their structure and hence modifying their biological role. This leads to DNA lesion, function loss enzymes, increased cell permeability, disturbed signaling over the cell, and to cell death (apoptosis) among others; ROS are also involved in inflammation. It is assumed that antioxidants might react with radicals to prevent cellular compounds becoming oxidized and, therefore, protecting the cell from the ROS. For example, there is growing evidence that quercetin (a flavonol) might inhibit the growth of tumour cells containing type II estrogen binding sites, including breast, colon, ovarian, leukaemia, gastrointestinal and meningioma cancer cells (4). Quercetin and related compounds might also have protective effect against cardiovascular diseases and stroke by participating in the reduction of platelet aggregation and vasoconstriction (3).

Major sources of polyphenols include berries, tea, beer, grapes/wine, olive oil, chocolate/cocoa, coffee, walnuts, peanuts, pomegranates, and other fruits and vegetables (5, 6). High levels of polyphenols can generally be found in the skins. Plants from the *Allium* family, such as onions, garlic or leek are particularly rich in polyphenols (both quantity and variety). Plants from the cruciferous family are rich sources of phytochemicals called glucosinolates.

Glucosinolates

Structurally glucosinolates (β -thioglucoside-*N*-hydroxysulfates) are characterised by the presence of nitrogen and sulphur groups, and are derived from glucose and an amino acid. Glucosinolates act as

secondary metabolites in cruciferous vegetables (such as *Brassicaceae*, *Capparidaceae* and *Caricaceae* and also in the genus of *Drypetes* in the *Euphorbiaceae* family (7)). Although their role in plants is unclear, their potent odour and taste suggests a role in herbivore and microbial defence. Glucosinolates are not bioactive until they have been enzymatically hydrolysed to the associated isothiocyanate by the endogenous myrosinase enzyme that is released by disruption of plant cells through harvesting, processing, or mastication. More than 120 types of glucosinolates, with varying side chains, have been isolated, but not all of these are present in edible plants (8).

Polyacetylenes, polyphenols and glucosinolates represent only a fraction of the huge range of phytochemicals present in fruit and vegetable varieties. The Network will eventually focus on other interesting phytochemicals such as carotenoids, terpenoids, phytosterols, alkaloids...from many different sources such as fruits, green leaf vegetables and potatoes.

Expected outcomes

The expected impact of the Network is to gain better understanding of the role and biological modes of action of phytochemicals at molecular, cellular and whole-organism level. A greater understanding of the roles of phytochemicals in promoting health will lead to improved formulation of foods, and to recommendations for consumers concerning the specific contribution made by individual bioactives in foods. The new food formulations, accompanied with nutrition and health claims, will increase competition and trade opportunities in Europe. European/Irish recommendations to promote health will be developed, taking into account the diverse eating patterns in Ireland.

The results will provide sound scientific data to support the common European policy on health and nutrition claims.

More information

Visit the project website at <http://www.ipfn.ie/>
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