Phytochemical Optimisation of Blueberry Juice

A research report presented in partial fulfilment of the requirements for the degree of

Master of Food Technology

Massey University, Turitea Campus, Palmerston North, New Zealand

Natasha Birt

2011

Abstract

Blueberries contain a high concentration and diversity of anthocyanins which are responsible for the blue/purple pigment of their skin. Like many other fruits and vegetables they also contain a large amount of chlorogenic acid (CGA) within the fruit flesh and seeds. Together these phytochemicals appear to account for most of the high antioxidant activity of the fruit, although within the scientific community a consensus has not been reached as to their effects on human health. Fresh blueberries have a limited season and are perishable unless stored frozen. Processing of blueberries into juice allows year round sale, and importantly less market-driven pricing. Therefore the aim of this research project was to investigate and optimise factors which may be significant in producing a high phytochemical blueberry juice.

The pigment of blueberries is concentrated in the skin, and therefore smaller blueberries have the highest anthocyanin concentrations on a weight basis. Consequently the three highest concentrations were found in cultivars 'Elliot', 'Burlington' and 'Duke'. Conversely chlorogenic acid is not restricted to the blueberry skin; 'Elliot', 'Bluecrop' and 'Burlington' had the three highest concentrations, while 'Duke' had the lowest. The profile of individual anthocyanins was also found to be diverse amongst cultivars. Therefore if individual anthocyanin(s) are shown to be important for specific health conditions further consideration should be given to cultivar selection.

Upon review of the current blueberry juice manufacturing process, large anthocyanin losses were seen at three key steps: after thawing of the fruit, removal of the press cake and holding of the juice between pressing and pasteurisation. Two alternative processes were compared where a slightly higher anthocyanin concentration was achieved for 'hot press juice' but a lower chlorogenic acid concentration than the alternative 'cold press' juice.

Modifications to the manufacturing process were investigated using the pilot plant at Massey University. It was found that blanching of frozen blueberries before pressing was successful in significantly increasing the anthocyanin and chlorogenic acid concentration of the juice (about a 5 fold increase of anthocyanins and a 4 fold increase in chlorogenic acid from previous levels). However, this did alter the sensory properties of the juice significantly, with a more cooked flavour and thicker texture. Other variations that were trialled, such as milling,

variation in holding time and temperature between pressing and pasteurising, had comparatively little effect on the anthocyanin and chlorogenic acid concentration.

Storage tests on blueberry juice showed a clear relationship between the storage temperature and anthocyanin retention, where warmer temperatures resulted in larger anthocyanin degradation. At the end of the six month storage period, juice storage at 5°C gave 63% anthocyanin retention while juice storage at 25°C gave only 8% retention. Some protection was also afforded to juice packed in glass bottles rather than plastic and stored in the dark rather than the light; but this difference was far smaller than the effect of temperature. Chlorogenic acid levels appeared to be comparatively less affected; only relatively small amounts of degradation were observed. It is important to note that when the antioxidant capacity was measured for stored juice at six months under the various treatments, there was only a small degree of degradation for all samples as compared with at time zero. Previously researchers had encountered a similar phenomenon and suggested that unknown anthocyanin degradation products may still be able to contribute to the juice's antioxidant capacity. However, here it is also suggested that chlorogenic acid may have had a more significant contribution to the antioxidant capacity that it is usually credited with, due to the large amount present with relatively little degradation throughout the storage period.

This information may be used to produce and market a juice with high anthocyanin, chlorogenic acid and/or antioxidant properties. Of the health effects evaluated here, currently, research in cardiovascular disease and neuroprotection effects are looking the most promising with regard to dietary blueberry supplementation in humans, although there is still a lack of double blind randomised placebo controlled studies to come to any consensus within the scientific community. Additionally, at the present time, the use of health claims on food products in New Zealand is being revised (Food Standards Authority proposal P293). As the current state of nutrition research surrounding plant polyphenols is inconclusive it may be important to use generic statements such as 'high in antioxidants' rather than statements about specific compounds.

Table of Contents

List of Tables

List of Figures

ACKNOWLEDGMENTS

To the client Mamaku Blue, for their fiscal support and never-ending enthusiasm. Thank you for accepting me as part of the Mamaku family.

To Technology New Zealand for the scholarship which made this project possible.

To my supervisors Julian Heyes and Alistair Carr for their guidance and wisdom along the way and many great learning opportunities. The lab technicians, particularly Michelle McGrath who were always patient and willing to help. Alongside this all the local and visiting students I worked with, particularly Giorgio Tibaldi and Khairul Kasim.

To my family and other friends who make life one worth living no matter how stressful it gets, thank you all for your love and support.