INTEGRATING RESEARCH IN FOOD AND HEALTH: A CASE OF PROMOTING HEALTH BY GLUCOSINOLATES IN *BRASSICA* VEGETABLES

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ABSTRACT

Many research findings in the area of food and health cannot be simply disseminated and implemented to have a direct impact on health promotion of the society. There is an interdependency between various types of researches to be considered prior to community outreach. On the other hand, population health is likely to benefit from a food supply of healthier food products, based on their contents of nutrients and health promoting compounds. Many factors should be considered before justifying that a specific food can promote health. Meanwhile, researchers may not comprehend the real needs and capacity of the society to built a well integrated research design. The incomprehensive diffusion of research findings to the society could lead to a very limited, if any, practical application of the knowledge. This paper discusses the integration and expected dissemination of research to the society by using the glucosinolates content in *Brassica* vegetables as a case study. *Brassica* vegetables, e.g. cabbages, broccoli, and cauliflower, have been widely investigated for their beneficial effects on human health, especially since *Brassica* vegetables contain glucosinolates. Previous studies reported an inverse association of *Brassica* vegetables consumption and the risk of certain cancers. However, this could not simply be translated into a health claim that increased *Brassica* vegetables consumption will reduce the risk of cancer. There are many factors that could affect the glucosinolates content and bioavailability after harvesting the vegetables, e.g. processing and preparation methods. Various processing methods, such as heat treatment and fermentation, considerably decreased the glucosinolates content. In order to preserve the content of glucosinolates, certain measures must be proposed, based on the understanding of the mechanism of glucosinolate degradation during any treatments. These measures must be integrated into practice in order to give a beneficial impact on population health within the community.

Keywords: *integration, research, food and health, glucosinolates, Brassica vegetables*

INTRODUCTION

It has been recognized in few past decades that food does not only provide basic nutrition, but can also prevent diseases and ensure good health. The contribution of the food to promote health or reduce the risk of disease becomes one of the quality attributes seek especially by the health-conscious type of consumers. The accumulation of scientific evidences which support the vital role of diet in overall health and well-being increase the consumers interest in healthy food (Rodriguez *et al*., 2006). Various studies have been focusing on the health promoting compounds in food and how these can promote health or reduce the risk of disease. An example is the studies on *Brassica* vegetables. These vegetables have been widely investigated for their beneficial effects on human health, due to considerable concentration of vitamins, minerals and a special group of phytochemicals, *i.e*. glucosinolates (GSs) (Bellostas *et al*., 2007).

Despite many research findings in the area of food and health, they cannot be simply disseminated and implemented in order to have a direct impact on health promotion of the society. In Indonesia for example, there can be a gap between the findings and the health promotion activities. The health promoting compounds in the food sometimes fragmentally disseminated, particularly in the popular media, into solely the health efficacy when one consumes the food. For example, informing that broccoli is like a *magic food* which can definitely reduce the risk of cancer (*e.g.* Anonim, 2013; Harmandini, 2010; Febrianindya, 2013). These are intended to promote the consumption of healthy food without further integrating other aspects in food and health. Bridging the information about food and health cannot be simply implemented by informing the efficacy of the compounds in the food. There should be a more comprehensive and holistic view so that consumers will not perceive the health efficacy of the food solely from the content information.

Moreover, on the other side researchers may not comprehend the real needs and capacity of the society to built a well integrated research design. The incomprehensive diffusion of research findings to the society could lead to a very limited, if any, practical application of the knowledge. This paper aims to discuss the integration of food and health and the expected dissemination of the research to the society, by using the glucosinolates in *Brassica* vegetables as a case study, particularly in the context of Indonesian society.

FOOD AND HEALTH

Population health is likely to benefit from a food supply of healthier food products, based on their contents of nutrients and health promoting compounds. Various terms have been used interchangeably to designate foods for disease prevention and health promotion. Functional food is the common term to describe the health promoting functionality of the food (Rodriguez *et al*., 2006). Within the few last decades, however, the term functional as it applies to food has adopted a different connotation—that of providing an *additional* physiological benefit beyond that of meeting basic nutritional needs (Hasler, 1998). The additional physiological benefit may vary for every functional food. It is well known that consumption of plant-based foods, including fruits, vegetables and whole grains, cereals and nuts as well as intake of marine foods and their long-chain fatty acids is instrumental in health promotion and disease risk reduction (Shahidi, 2009). Overwhelming evidence from epidemiological, in vivo, in vitro, and clinical trial data also indicates that a plant-based diet can reduce the risk of chronic disease, particularly cancer. There are components in a plant-based diet other than traditional nutrients that can reduce cancer risk. Although the vast number of naturally occurring health-enhancing substances are of plant origin, there are a number of physiologically-active components in animal products that deserve attention for their potential role in optimal health. However, the functional foods are not a magic bullet or universal panacea for poor health habits (Hasler, 1998).

It is known that the phytochemical composition can vary markedly as a function of such factors as cultivar, degree of maturity at harvest, climatic or geographic effects, soil composition, cultivation practices, part of the plant utilized. Agronomic and post-harvest handling and processing measures can be taken to insure high levels of these compounds in the diet (Rodriguez *et al*., 2006). These factors should be integrated in determining the efficacy of phytochemicals in certain food and its effect towards health, as this will be further discussed by using the health promoting compounds, *i.e*. glucosinolates, in *Brassica* vegetables and the impact of processing on the compounds.

GLUCOSINOLATES

Brassica vegetables, *e.g*. cabbages, broccoli, and cauliflower, have been widely investigated for their beneficial effects on human health, especially since these vegetables contain glucosinolates (GSs). GSs are a group of plant secondary metabolites, with a common structure of β-thioglucoside N-hydroxysulphates with a sulphur linked β-D-glucopyranose moiety and side group (R). The side chain R determines the characteristic of GSs, whether it is defined as aliphatic, aromatic or indole. Among other economically important vegetables frequently consumed, *Brassica* vegetables are major sources of GSs (Fahey *et al.* 2001).

In an intact plant tissue GSs are occurred in separate compartments with the enzyme myrosinase. GSs are highly prone to degradation by myrosinase-catalysed hydrolysis upon cell disruption. The activity of myrosinase itself is influenced by intrinsic and extrinsic factors, such as ascorbic acid, $MgCl_2$, pH, temperature, and pressure (Ludikhuyze *et al.* 2000).

Based on epidemiological evidence reports, Herr and Büchler (2010) suggested that these vegetables contain chemo-preventive agents against lung, colorectal, breast, prostate, pancreatic, and possibly also gastric cancers. It is the GS content that is assumed to be accountable indirectly to lower the risk of cancer (Verhoeven *et al*., 1997). Isothiocyanates, one of the GSs breakdown products, can reduce the risk of cancer by inhibiting phase 1 and inducing phase 2 enzymes during carcinogen metabolism. Isothiocyanates act on the process of carcinogenesis by influencing phases of tumor initiation, promotion and progression, and by suppressing the final steps of carcinogenesis (Traka and Mithen, 2009). However, this could not simply be translated into a health claim that increased *Brassica* vegetables consumption will reduce the risk of cancer.

There are many factors that could affect the glucosinolates content and bioavailability after harvesting the vegetables, *e.g*. processing and preparation methods. (*e.g*. Slominski and Campbell 1989; Rungapamestry *et al.* 2006; Moreno *et al.* 2007; Volden *et al.* 2008). Moreover, the GSs content can vary over 100 fold as a result of variations caused by differences in cultivars, cultivation practices, processing, cooking and preparation methods, and also storage conditions (Verhoeven *et al.* 1997; Verkerk *et al.* 2001; Verkerk and Dekker 2004; Verkerk *et al.* 2009). Each type of processing and storage has its typical condition, even within the same processing type, there are variability of conditions such as time-temperature, ratio of vegetables and medium, and cooking wares conditions. Therefore, different processing and storage may affect in different amounts and profiles of GSs.

EFFECT OF PROCESSING

Brassica vegetables are mainly consumed after some types of processing, *e.g*. boiling, steaming, microwave processing, stir-frying, or fermentation. These various processing methods can considerably decrease the glucosinolates (GSs) content. For example during boiling, losses of 5-20% of GSs due to thermal breakdown (Oerlemans *et al.*, 2006; Dekker *et al.*, 2009; Jones *et al.*, 2010) and losses of 25%-75% of GSs due to leaching are typically expected (Rosa and Heaney, 1993; Dekker *et al*., 2000; Volden *et al.*, 2008). Meanwhile, fermentation was reported to reduce total GSs content substantially. No GSs content was observed in fermented cabbage and stored sauerkraut (Daxenbichler *et al.*, 1980; Ciska and Pathak, 2004). During sayur asin making, fermentation considerably reduced the GSs content in Indian mustard (*Brassica juncea*), particularly after one day of fermentation (Nugrahedi *et al*. *under preparation paper*)

Nugrahedi *et al*. (2013) currently reviewed the effects of processing on the GSs content in *Brassica* vegetables and analyses these changes of GSs by discussing the relevant mechanisms for each processing method. It was shown that different conditions in processing *Brassica* vegetables can have a significant influence on the final intake of GSs. Processing changes GSs content through several mechanisms, such as enzyme-catalysed breakdown, thermal breakdown, cell lysis, and leaching (Dekker *et al.*, 2000). Each processing method involves specific conditions, which lead to various degrees of impact of the different mechanisms on the GSs content. In order to preserve the content of GSs, certain measures must be proposed, based on the understanding of the mechanism of glucosinolate degradation during any treatments.

INTEGRATING RESEARCHES FOR COMMUNITY OUTREACH

In the case of GSs in *Brassica* vegetables, the efficacy of *Brassica* vegetables as a functional food depends on many factors. These factors must be integrated in disseminating the research finding that stated that these vegetables can promote health and reduce the risk of disease. One should consider the interdependency between various types of studies prior to community outreach. In order to materialize the full potential of phytochemicals/functional foods, a holistic, concerted, multidisciplinary approach is imperative, involving workers in diverse fields such as nutrition, medical sciences, epidemiology, statistics, immunology, analytical and organic chemistry, biology, biochemistry, agriculture, food science, food technology and engineering (Rodriguez *et al*., 2006).

A number of factors complicate the establishment of a strong scientific foundation, however. These factors include the complexity of the food substance, effects on the food, compensatory metabolic changes that may occur with dietary changes, and, lack of surrogate markers of disease development. Additional research is necessary to substantiate the potential health benefits of those foods for which the diet-health relationships are not sufficiently scientifically validated. A convincing scientific relationship between food and its health effects can be established by using the following methods of investigation: epidemiological studies, biological and experimental studies, and intervention trials. No single study design can stand on its own (Rodriguez *et al*., 2006).

CONCLUSION

Studies on the area of food and health must be integrated in order to give a beneficial impact on population health within the community. In the case of glucosinolates, the health promoting compounds commonly found in Brassica vegetables, there are factors, such as the variety, environment, agricultural practices, postharvest handling, and preparation and processing, that must be considered before integrating and promoting the health properties into society.

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