A Review on Kale as a Substantial Meal

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Abstract

An immensely popular 'superfood', Kale (Brassica oleracea var. acephala) is a cruciferous vegetable which can be distinctly identified by its leafing stem. Scientific evidence supports the claim that including the vegetable in diet can bring about good health in humans as it is rich in vitamins particularly vitamin c, pro-vitamin A and minerals such as calcium, phosphorus, potassium, magnesium and iron, it is reported to have highest concentration of anti-oxidants. However, it is hailed as one of the healthiest vegetables in popular culture. This study is an investigation of the reasons behind the popularity of kale. The review looks at phytochemical content to understand the possible reasons for its popularity in kashmir and can be used for various metabolic diseases especially Diabeties

Key Words: Kale, Phytochemicals, Genotypes

DOI Number: 10.14704/nq.2022.20.8.NQ44238 **NeuroQuantology 2022; 20(8):2168-2172**

Introduction

Diabetes mellitus is increasing at worrying pace worldwide. It is suggested that currently approximately (422–425) million adults are effected with the disease and if left unchecked it is expected the number may rise to almost 629 million (48% increase) by year 2045, if the necessary and adequate measures are not taken now. As far as developing countries like India is concerned where resource limitation is a common issue, diabetes represents a major challenge. This disease is an endocrinological disorder characterised by uncontrolled hyperglycemia, due to the dysregulation of glucose metabolism. It may be caused mainly due to partial or complete inability of the production or secretion of insulin from pancreatic beta cells or incapability of cellular tissue to respond to serum insulin levels. Diabetes can be mainly classified as either type I diabetes, where beta cells in the pancreas of a diabetic patient are killed by autoimmune system leading to the production of lesser insulin for glucose metabolism or type II diabetes where body cells becomes resistant to insulin action. The Type II diabetes is increasing alarmingly with more than 150 million people currently being affected by this disease at global level and among which 90% comprise adult population. Although, a number of pharmacological drugs including insulin or oral hypoglycemic drugs are available in the market to control numerous aspects of this diseases, but the multiple complications is a common outcome of this disease, with a continuous and concomitant rise in mortality index. Thus, there is an urgent need to search and develop some novel therapeutics or drugs against diabetes, with much greater efficacy and potency. In this regard, phyto-therapy has a great potential and numerous plants have been used in various traditional systems of medicine in ancient times, especially with respect to diabetes treatment. Although, a number of plants have been reported to exhibit antidiabetic activity, however, without any solid scientific evidence more research needs to be carried out in this direction. Recent research suggests that several plant extracts can act as natural inhibitors of carbohydrate metabolizing enzymes and thus possess an immense potential for the management of postprandial hyperglycemia linked to diabetes. In this context, a traditional vegetable- Kale (B. oleracea L var. acephala) of Kashmir region has a great potential to act against various degenerative diseases due to high antioxidant nature but the vegetable is highly unexplored.

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Further, it has been reported to be rich source of secondary metabolites including carotenoids, alkaloids, sterols, phenolic compounds and flavonoid etc and, it is the presence of these bioactive molecules, that may accounts for most its bioactive and pharmacological actions. Besides, it is loaded with a high content of bioactive glucosinolates like isothiocynates, thiocynates, nitriles, and epithionitriles. The overall biological activities which are associated with kale includes antioxidant activity, anti-cancerogenic activity, antidiabetic and protection to cardiovascular and gastrointestinal tract. As far as the anti-diabetic potential of this crop is concerned, it is highly unmapped and the exact anti-diabetic mode of action of this crop have not been properly elucidated.

3. Phytochemistry of Kale

Newly practised approaches to metabolic profiling in plant based food have made the process of identification of phytochemicals much faster. Targeted and untargeted analysis are two approaches to metabolomics. While focused analysis entails the determination of targeted metabolites, several hundred metabolites have been globally identified by the process of untargeted analysis. Though an untargeted review is absent in case of kale, targeted study shows the presence of chemicals such as glucosinolates, polyphenols and carotenoids, which give cruciferous vegetables its cancer prevention benefits. Referring to the paper by, Jeon et al. (2018), the study supports the claim that the health benefits of kale is due to the presence of the mentioned metabolites.

3.1 Glucosinolates

The health benefits of Kale is due to the presence of glucosinolates which are sulphur containing compounds. Around 200 different varieties of aliphatic, aromatic, and indolic glucosinolates have been discovered, and their genetic makeup determines their presence in cruciferous foods. Various plants of the Brassica species have a profile of about ten different characteristic glucosinolates out of which three to four are present in maximum quantities. Glucosinolates are inactive and need to be enzymatically hydrolysed by myrosinase to get activated and form various breakdown products like isothiocyanates, nitriles, thiocyanates, epithionitriles, and oxazolidinethiones (Vaughn and Berhow 2005; Cartea et al. 2008). Glucobrassicin-indole-3-carbinol and its further derivative 3,3′-diindolylmethane are two breakdown products that have received immense interest from the scientific community for its chemoprotective features(reviewed by Fujioka et al., 2016). Glucosinolates like sinigrin (and its hydrolysis product allyl isothiocyanate) and glucoraphanin (and its product sulforaphane) are thought to have therapeutic, cancer and diabetes resisting capabilities respectively((Mazumder, Dwivedi and Plessis 2016),(Elbarbry and Elrody .2011).The kale sprout(10 day old)contains the glucosinolates, glucobrassicin and sinigrin like a mature plant Jeon et al. (2018). However, when compared to other foods of the cruciferous variety like broccoli and Brussels, glucobrassicin was found to be much lesser quantity in kale.(Charron,saxton and sams 2005) As of other Brassica species, the glucosinolate content depends on factors such as the cultivation and location. However, kale still does not possess a genetic, which could cause increased glucosinolates(Charron,saxton and sams 2005,steindal et al 2015)

3.2 Phenolic Compounds

Phenolic compounds are group of specialized metabolites with multiple health benefits. 2169

They are the extensively group of specialized metabolites associated to management of obesity (Farhat Drummond and Al-Dujaili 2017), type 2 diabetes (Guasch-Ferré et al.,2017), metabolic syndrome (Chiva-Blanch and Badimo, 2017), neurodegenerative diseases (Hossen et al., 2017), atherosclerosis (Bahramsoltani et al., 2017) and cancer (Russo, Tedesco, Spagnuolo and Russo 2017).The group of polyphenols most extensively studied are flavonoids and are dominant in kale. Phenolic acids, derived from benzoic and cinnamic acids, present a wide range of phenolic compounds which have various health benefits. The ones most commonly found are caffeic, ferulic and sinapinic acid. When compared to other plants of the Brassica variety, none stood out for being particularly rich in phenolic compounds.

3.3 Carotenoids

Kale, like other cruciferous foods, is rich in β-carotene (or provitamin A) and lutein which is beneficial to ocular health.(manikandan et al.2016).The caretenoids which are present in kale are lutein,beta carotene,alpha carotene, neoxanthin, lycopene(rodriguez-amaya 2005 and joen et al.,2018).These are also good for hair, skin, bones, and the respiratory system. However, the amount of carotenoids present in kale depends on growing conditions and environmental factors in the growing and maturity period. Kurilich et al. (1999) compared β-carotene quantities in different cruciferous plants and concluded that kale contained the highest.

3.4 Biological Activity

In vitro and in vivo are the methods by which the biological activity of a food component can be tested. In vivo research on kale has remained very limited.The main activities associated with kale includes mainly antioxidant activity, anticarcinogenic activity and the protection of cardiovascular and GI tract.

3.5 Antioxidant Activity

Compounds such as polyphenols, carotenoids, and glucosinolates along with vitamin C and E have an antioxidant effect. Phytochemical-rich food with high antioxidant activity plays a preventive role in chronic diseases by reducing the free radicals and reactive oxygen species(ROS). The antioxidant activity of kale was evaluated by invitro methods (Zhou and Yu 2006; Ayes et al. 2008; Hagen, Borges, Solvang andBentsen 2009; Korus and Lisiewska 2011; Korus 2011; Becerra-Moreno et al. 2013). Several studies such as Sikora et al. (2008) and Zhou and Yu (2006) compared the antioxidant activity of kale with other cruciferous vegetables and regularly consumed vegetables respectively, and kale was found to have the highest by a large margin.

3.6 Anticarcinogenic Activity

Increased intake of cruciferous vegetables has been associated with reduced risk of various types of cancers related to reproductive system, (Liu, Mao, Cao and Xie 2012; Liu and Live, 2013; Han, Li and Yu 2014),gastrointestinal system (Wu et al., 2013a; Wu et al., 2013c), urinary system (Liu et al., 2013a; Liu etal., 2013b) and lung (Wu et al., 2013b .Indole-3-carbinol which is the hydrolysis breakdown product of glucobrassicin has been most extensively studied for its cancer chemoprotective features. However, not much is known about its bioactivity except that it requires myrosinase which is present in equal quantity in kale and broccoli. Antigenotoxicity is the ability to prevent genetic damage within the cell which may lead to mutations and cause cancer. This potential has been confirmed in kale. Radošević et al(2017) studied cytotoxicity of B. oleracea from italica and acephala groups on a breast adenocarcinoma (MCF-7) and cervical cancer (HeLa) cells line. Tested extracts showed inhibitory effect on cell viability with concentration 50 and 100 mg/ mL

3.7 Effects on Gastrointestinal Tract

Antiulcer activity of plants of acephala group makes them useful remedies for gastric and peptic ulcers.((Lemos et al., 2011).gastric ulcers are mainly caused by infection of bacteria that is Helicobacte pylori, which dramatically enhance the risk of gastric cancer (Fahey, Stephenson, Wade and Talalay 2013). They found that glucoiberin hydrolysis product sulforaphane (Figure 1) inhibits extracellular,intracellular, and antibiotic-resistant strains of Helicobacter pylori and prevents some types of stomach tumors. As we mention above, kale contains glucoraphanin, which is sulforaphane precursor, therefore, antiulcer activity of kale may be related with the sulforaphane anti- Helicobacter pylori activity.

Kale also possesses antimicrobial activity against Staphylococcus aureus, Enterococcus faecalis, Bacillus subtilis and Moraxella catarrhalis (Ayaz et al., 2008). Glucoraphanin, a sulforaphane precursor
present in kale is what gives it its antiulcer activity.A diet rich in prebiotics promotes intestinal microbial diversity, invigorates the immune system, decreases the risk of colon cancer, and maintains cholesterol levels among other health benefits.(dey, 2017). Thavarajah et al., (2016) showed that kale is rich in prebiotic carbohydrates, which may be the reason for it being a 'superfood'.

3.8 Effects on Cardiovascular System

Polyphenols, glucosinolates, vitamin C and E, are associated with cardiovascular protection.(din 2012) The cruciferous vegetable due to presence of bioactive compounds can reduce LDL, to combat free radicals and regulate GST activity.(manchali et al.,2012) Kale has been found to have the highest bile acid binding when compared to other vegetables.(kohlon 2007) This potential increases after steam cooking, which means that kale has a positive effect on the cardiovascular system and lowers the risk of cancer consumed after being cooked.

Cardiovascular diseases are caused by inflammation and are therefore preventable by intervention by compounds that have an anti-inflammatory effect. Kale, which is rich in carotenoids and flavonoids, thus contributes to cardiovascular protection.(ciccone et al.,2013)

Conclusion

The popularity of Kale (brassica oleracea var.acephala) is increasing but the research on acephala group is very little.. Though in vitro antioxidant and anticarcinogenic activity of kale has been studied, in vivo characteristics remain unknown particularly in kashmir valley. Folate, riboflavin, and vitamin C, K and A content is higher in kale than other cruciferous. Though the levels of specific phytochemicals are influenced by environmental growth factors, those present in kale are more or less comparable to other vegetables of the specials. Kale could be considered a superfood like other cruciferous and as reported being rich source of secondary metabolites it has a great potential to act against various degerative diseases.

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