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Evaluation of Climatic and Topographical Effects on Bioactive Compounds and Mineral Profiles of Two Selected Samples of Cauliflower

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Abstract

The principal endeavor for this study was to appraise the phenolic content, total flavonoid content, antioxidant activity, antimicrobial activity and mineral profiling in Cauliflower (*Brassica oleracea botrytis*) extracts from two different regions, which are Soon valley and Sargodha vicinity, having diverse environmental and ground water impact. The extracts, taken out by 100%, 80% methanol and distilled water separately, showed crude yield in the range of 3.93 - 21.3 g/100g with no significant difference between the two areas. TPC (Total phenolic content) and TFC (total flavonoid content) were between 10.15 - 11.76 GAE mg/100mg and 15.72-33.50 mg/g respectively. Although TPC and TFC also differ in values depending upon the solvent system used but the extracts of Soon valley exhibit higher values, especially individual phenolic acids profile was significa ntly better for the extracts of Soon valley. Similarly, the reducing potential and DPPH radical s cavenging assay showed the values of 214.28-1196.46 mg/mL and 0.55-3.16 mg/mL respectively. Moreover, the extracts demonstrated minerals contents i n the range of 0.049-1.9650 mg/kg, with significant higher quantities of Pb and lower quantities of Co in the samples of Sargodha region. The extracts exhibited significant antimicrobial activity against *E. coli* (11.37- 21.81 mm/DW), *S. aureus* (8.22-18.27mm/DW), *B. substilis* (9.5-19. 56 mm/DW), and *S. typhae* (8.49-13.5 mm/DW), but the samples from Sargodha region were more potent. Study indicates that Cauliflower from Soon valley has more antioxidant activity, fewer amounts of heavy metals and lesser antimicrobial activity as compared to Sargodha region.

Keywords: Phenolics, Anitoxidants, Biological activity, Mineral profile, Cauliflower

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1. Introduction

The most important, safer and compatible sources of natural antioxidants are plants, vegetables and fruits. Substantial evidence is reported in the literature that the intake of natural products have been associated with lower incidences of chronic diseases such as cancer and heart disease. In addition to vitamins and minerals, phytochemicals such as flavonoids and phenolics may exert preventive and/or therapeutic effects for human diseases. Many of these natural products have antioxidant activity and may help to protect the cells against the oxidative damage caused by free radicals (Dimitios *et al*., 2006). In this scenario, functional foods have a potentially positive effect on health beyond basic nutrition. (Sánchez-Salcedo *et al*., 2015; Venkatesh *et al*., 2008).

In living organisms oxidation reactions produce free radicals which cause the oxidation of bio-molecules like lipids, DNA, RNA and proteins etc. (Niwa *et al*., 2001; Bergman *et al*., 2001). Extra affinity of Lipids to lose electrons make them target for per-oxidation and ultimately for the causation of diseases. Whereas the food issues concerned, the shelf life of fresh and processed foods

decreases by oxidative reactions. Lipids oxidation effects the color, taste and consistency of food (Siddiq *et al*., 2005; Anwar *et al*., 2007) resulting in economic loss (Akram *et al*., 2009). The human health is also affected due to toxicity of oxidized oil and other preserved food stuff (Anwar *et al*., 2006). Damage by free radicals in biological systems is retarded by antioxidants. Antioxidants have the ability to capture or quench those radicals that are involved in causing damage to human body and food. Inhibition of lipid per-oxidation and other radical mediated processes are also done by antioxidants (Anwar *et al*., 2009). They are also very important in increasing the shelf life of food which is affected by oxidative reactions. Synthetic antioxidants are mostly used in food processing and pharmaceuticals industries, but they have many side effects such as Liver damage and carcinogenic effects (Anwar *et al*., 2008). So, there is need to explore and isolate natural antioxidants, which have very fewer or no side effects and can be used in medicines in place of synthetic antioxidants (Karoui *et al*., 2013).

Minerals, available in trace amount in living systems, are the major part of different enzymes that regulate the biological processes (Dashti *et al*., 2004). There are 25 elements or minerals that are found in human body and among them 20 are most important (Crews, 1998). Lack of a particular mineral may lead to a specific disease in the living beings, like deficiency of iron may result in anemia and deficiency of iodine may cause goiter. Therefore, all these minerals and nutrients must be in proper range and concentration in body fluids, as higher amount also disturb the normal physiologic and metabolic functions of body or living beings. Fruits and vegetables have been a good source of all these required minerals (Connor, 1995) and thus their use is helpful in preventing diseases, maintaining body and blood pH and retaining proper physiologic functions (Underwood, 1971).

Brassica family (broccoli, Cauliflower, cabbage and Brussels sprouts) are the vegetables which are excessively used in the world and have enough amounts of antioxidants and other valuable phyto-chemicals in them (Gulcin *et al*., 2004; Sharma *et al*., 2005). Cauliflower plants can grow in a wide range of climatic, topographical and soil conditions, which may affect its chemical composition and nutritional status of the plants. Cauliflower may also contain different concentration of several minerals depending upon the area, atmospheric conditions, underground water and different types of fertilizers which are used to assist its growth during cultivation.

In this scenario, it is of interest to evaluate antioxidant attributes, biological activities, phenolic acids composition, and minerals profile of cauliflower, thereby to assess the effect of climatic, topographical and soil conditions on phenolics and flavonoids composition, antioxidant activity, and mineral profile. For this purpose depending upon the diverse environmental and ground water impact, two different samples of Cauliflower from two different areas, such as Sargodha region (S.R) and Soon Valley (S.V) of Pakistan, were collected and their above mentioned parameters were assessed by using organic solvent systems.

2. Material and Methods

2.1. Sample collection and preparation

Brassica olereacea samples were collected from Soon valley and Sargodha vicinity. The samples were thoroughly washed to remove dust and other impurities and were dried in open air. Controlled grinding is performed so that powder particles can pass through 80 mesh sieve. Ground powder of samples was placed in refrigerator for further analysis. All chemicals which were used in research analysis, were German made and of analytical grade, bought from Sigma Aldrich corporation.

2.2. Preparation of extracts

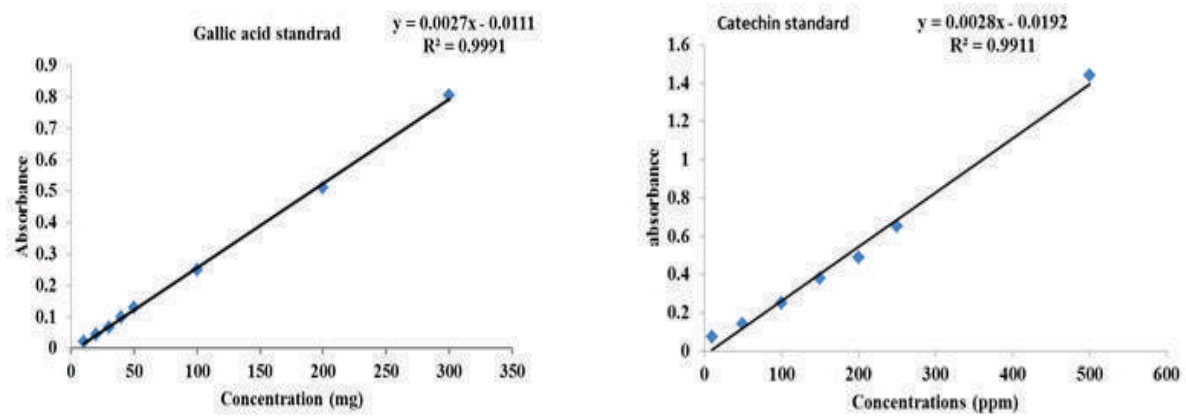
Extraction of samples was done by different solvents e.g. 100%, 80% methanol and distilled water. Ratio of sample and solvent was kept as 1/10 (w/v). Extraction was done for 6 hours thrice by using orbital shakers. Extract was separated by the process of filtration by keeping residue left behind. These extracts were concentrated by using rotary evaporator at reduced pressure. After that extract was kept in refrigerator at a temperature of 4 ^{o}C and then used for further analysis (Chatterjee *et al*., 2010).

2.3. Total phenolic contents (TPC) determination

Folin Ciocalteu is used to assess the amount of TPC. 1 mL of distilled water is added in 100 mg crude extract of samples. 20 µL of this prepared sample (2 mg/mL) was taken in test tube and marked the volume up to 0.5 mL by adding 480 µL of distilled water. Then 0.1 mL (100 µL) of Folin Ciocalteu (0.5 N) was added and keep the mixture for 15 minutes. Then 2.5mL of 7% Na_2CO_3 (w/v) solution was added to make the total volume 3.1mL. Incubation was performed for 30 minutes on room temperature. TPC amounts were calculated by using Gallic acid calibration curve within the range of (10-300) ppm (R^2=0.9991) Figure. 1A. Results were expressed as Gallic acid equivalents GAE mg/100 g of dry plant matter.

2.4. Determination of Total Flavonoid Contents (TFC)

The contents of total flavonoid were determined by the procedure followed by (Zhishen*et al*. 1999). The results were expressed as catchin equivalent (10-500 ppm) (R2=0.918) CE mg/g of dry weight. Assay was performed in triplicate. Amounts of TFC were calculated by using calibration curve of catechin in the range of (10-500) ppm having (R2=0.991) Figure 1B and results were calculated as Catechin Equivalent (CE) per dry matter.



(A) (B)

Figure 1. A. Gallic acid standard curve used for the calculation of Gallic acid equivalents for tested samples. B. Catechin standard curve used for the calculation of Catechin equivalents for tested samples

2.5. Assessment of antioxidant activity

The antioxidant activity of samples was assessed by 1, 1 diphenyl-2-picrylhydrazyl radical (DPPH) scavenging assay described by (Zhuang *et al*., 2012). BHA that is synthetic antioxidant was used as a positive control. Calculation was made at IC50, concentration of extract that is scavenged/ neutralized 50% of DPPH free radicals.

2.6. Phenolics profile calculation

Phenolics profile was assessed by HPLC individually. Separation was carried out on HPLC ODS reversed phase column (Petropoulos *et al*., 2002). Acidified acetonitrile (99.5%) was mobile phase at a constant rate of 1 mL/min. 20µL sample was injected in column every time and detection wavelength was 280 nm. Phenolic compounds were detected by comparing their retention time with pure standards of targeted compounds.

2.7. Reducing power determination

Cauliflower extracts reducing power was determined according to the procedure described by (Sahito *et al*. 2002) with a slight modification. Different concentrations of each sample (1-3 mg/mL) were made in phosphate buffer (pH 6.6) and total volume of solution was marked to 3.5 mL. Then 2 mL of 1% potassium ferricyanide was added. Place the mixture for 20 minutes in oven at 50 °C. Then 1 mL of 10% trichloroacetate was added and centrifuged for 10 minutes at 650 rpm. 2.5 mL of supernatant was separated and then 2.5 mL of distilled water was introduced and absorbance was taken at 700 nm. Reducing power was calculated by linear line equation.

2.8. Mineral Profiling

Wet digestion of the samples (both from Soon valley and Sargodha region) was performed to make the samples transparent and free from any organic matter. One gram of both the samples was weighed and treated with 5 mL of conc. HNO_3 in a beaker separately. The samples were heated at 70-80 °C for ten minutes followed by increase of temperature to 150 °C. Solvent was evaporated and residue was kept overnight. 5mL of conc. H_2SO_4 and 5 mL of H_2O_2 was added drop wise followed by 10 mL of deionized water. Then the solution was filtered and total volume of filtrate was made to 15 mL with deionized water (Adeyeye *et al*. 1999; Akpanyung 2005).

2.9. Preparation of Standard solutions for analysis

For determination of mineral profiling, standard solutions of seven metals were prepared from their parental salts. Standard solutions for Cd, Co, Cu, Ni, Cr, Pb were prepared from their sulphate salts and Zn solution was prepared from $ZnCl_2$ for determination of concerned elements by atomic absorption spectrophotometer. Absorption of series of standard solutions of known concentrations of each metal was determined and concentration of cauliflower samples was determined from graph.

2.10. Antibacterial activity

The Antibacterial activity of the extracts was determined by measuring minimum inhibitory concentration method (MIC). Nutrient agar (Oxoid) was prepared and then autoclaved. Before transferring this medium in sterilized Petri plates, 100 µL inoculum was added in medium while it was liquid and quite cool, mixed and then poured into petri plates. After that 6 mm Wicks paper discs were laid flat on growth medium and 100 ul was put on each disc. The Petri plates were then incubated at 37 °C for 24 h, for the growth of bacteria. The extracts having antibacterial activity, inhibited the bacterial growth and clear zone of inhibition was formed. The zone of inhibition was measured in millimeters (Sarpeleh *et al*., 2009). The bacterial strains that used were *Bacilus Substilis*, *Streptococcus aureus*, *Salmonella typahe* and *E-coli*. Ciprofloxacin was used as standard.

2.11. Statistical analysis

Statistical Analysis Data was expressed as mean values at 95% confidence interval. Analysis of variance was performed using ANOVA procedures. Significance difference for values with respect to means of samples and solvents were determined. P> 0.05 means no significance difference. Analysis was done by using SPPS 16.0 software.

3. Results and Discussion

3.1. Extraction yields

The extraction of different compounds from plant material is dependent upon quantity, composition and nature as well as time duration consumed in extraction (Hsu *et al*., 2006). Therefore optimal conditions should be availed to get excellent extraction yield. Data for the percentage yield of cauliflower samples extracted in pure methanol, 80% methanol and distilled water for Soon Valley and Sargodha regions is given in table 1.

Percent yield of dried extract of cauliflower in 80% methanol, 100 % methanol and in distilled water was observed to be 21.30%, 18% and 3.93% for Soon valley region, and 17.52%, 17.65% and 4.96% for Sargodha region respectively. It became evident from the results that generally high extraction yield was observed in cauliflower samples from Soon valley as compared to samples from Sargodha region. Statistical analysis (P>0.05) showed insignificant variation in percent yield of both extracts of cauliflower.

Table 1. Extraction yield (g/100g of dry weight) of cauliflower extracts using different solvents

Solvent system used for extraction	**Soon valley cauliflower** **% Extraction yield**	**Sargodha region cauliflower** **% Extraction yield**

80% methanol	21.3 ± 0.397	17.52 ± 0.320
100% methanol	18 .0 ± 0.246	17.65 ± 0.316
Distilled water	3.93 ± 0.203	4.93 ± 0.203

3.2. Total Phenlic content

The Folin ciocalteu method was used to access the total phenolic contents from cauliflower samples because this method has less interference and rapid in finding phenolic from sample (Sultana *et al*. 2007). The total phenolic contents of the dried extracts of cauliflower in 80% methanol, 100% methanol and in distilled water were observed to be 11.76, 11.45 and 11.17 (GAE) mg/100 g for soon valley region and 10.86, 10.59 and 10.15 (GAE) mg/100 g for Sargodha region respectively. It was clear from the results that TPC was in high concentration in the samples of soon valley as compared to the samples of Sargodha region. The values showed a slight difference between the TPC of the two regions. The maximum concentration was observed in samples extracted in 80% methanol. Furthermore, a minute effect of solvent composition on extracts of both regions was seen there. (Table 2)

Table 2. Total Phenolic content in two different samples of cauliflower

Sample region	**Solvent type**	**TPC(GAE) mg/100g**
Soon valley	80% methanol	11.76 ± 0.40
	100% methanol	11.45 ± 0.30
	Distilled water	11.17 ± 0.09
Sargodha region	S.R 80 % methanol	10.86 ± 0.22
	S.R100% methanol	10.59 ± 0.08
	Distilled water	10.15 ± 0.30

3.3. HPLC analysis for determination of individual phenolic acids

Three types of phenolic acids (gallic acid, protocatechuic acid and p-coumaric acid were present in cauliflower sample of both regions given in Table 3. Gallic acid was present dominantly in both regions. In Soon valley sample, Gallic acid was present in 100% methanol (10.52 mg/L) and in distilled water extract (24.14 mg/L) but was absent in 80% methanol. Similarly p-coumaric acid was (1.18 mg/L) in 80% methanol and (14.68 mg/l) in 100 % methanol, while the amount of protocatechuic acid was observed as (25.07 mg/l) in only 80% methanol. In Sargodha region sample, Gallic acid was present in 100% methanol as (16.81 mg/L) and in 80% methanol as (4.08 mg/L). The amount of protocatechuic acid was present in only distilled water extract as (36.3 mg/kg). While p-coumaric acid was absent in all three sample extracts of Sargodha region. It became evident from the results that the concentration of gallic acid is high in Sargodha region than in soon valley in same solvent (100% methanol). Furthermore the amount of protocatechuic acid was higher in distilled water extract than in 80% methanol.

Table 3. HPLC analysis for determination of phenolic acids

Sample region	**Solvent type**	**Phenolic acids in mg/kg**		
		Protocatechuic acid	**p- coumaric acid**	**Gallic acid**

Soon valley	80% methanol 100% methanol Distilled water	25.07± 0.061 - -	1.18± 0.085 14.68± 0.060 -	- 10.52± 0.260 24.14± 0.523
Sargodha region	80 %methanol 100%methanol Distilled Water	- - 36.3± 0.176	- - -	4.08± 0.09 16.81± 0.136 -

3.4. Total Flavonoid content

TF contents were determined following a reported procedure (Dewanto *et al*. 2002). The total flavonoid content of dried extract of cauliflower in 80% methanol, 100% methanol and in distilled water was observed to be 15.72, 32.28 and 33.4 mg/g from soon valley region and 24.07, 22.50 and 33.50 mg/g from sample of Sargodha region respectively. High content of flavonoids was observed in extract of distilled water for both regions (Table 4).

Table 4. Determination of total flavonoids content

Sample region	Solvent type	TFC (mg/g)
Soon valley	80% methanol	15.72 ± 0.085
	100% methanol	32.28 ± 0.165
	Distilled water	33.4 ± 0.216
Sargodha region	80 % methanol	24.07 ± 0.041
	100% methanol	22.50 ± 0.257
	Distilled water	33.50 ± 0.238

3.5. DPPH radical scavenging assay

All cauliflower samples extracted in 100% methanol, 80% methanol and distilled water were observed to exhibit appreciable scavenging activity ranging from 65.0-73.0%, 56.0-88.0%, 23-48% for soon valley region and 52.0-92.0%, 64.0-77.0%, 54.0-73.0% for sample of Sargodha region. DPPH radical scavenging activity increased in a concentration dependent manner (table 5). IC 50 values for 100% methanol, 80%methanol and distilled water were 453, 287.82 and 341.34 mg/mL for soon valley region and 214.28, 1196.46 and 447.36 mg/mL for Sargodha region.

3.6. Reducing power

The reducing potential was measured over the concentration range of 1-3 mg/mL. Results showed general increase in activity when concentration increased. Reducing potential of 80% methanol, 100% methanol and distilled water extracts of cauliflower were in the range of 0.155-3.14, 0.991-3.022, 0.871-3.08 respectively for soon valley sample and 1.09-3.16, 0.55-2.62 and 0.96-3.01 respectively for Sargodha region sample. Significant difference in reducing potential of both regions was observed at 2 mg/mL in 100% methanol cauliflower extract. The reducing potentials of various extracts are given in Table 6.

Table 5. Determination of DPPH radical scavenging activity (IC50)

Sample region	Solvent	IC 50 (mg/mL)

Soon valley	80% methanol	287.82 ± 0.05
	100% methanol	453.00 ± 0.015
	Distilled water	341.34 ± 0.10
Sargodha region	80% methanol	1196.46 ± 0.07
	100% methanol	214.28 ± 0.065
	Distilled water	447.36 ± 0.0035

3.7. Minerals Profile

The concentrations of various metals in Cauliflower from two selected regions are given in Figure 2. There is a considerable variation in mineral contents of vegetable among the two selected regions. Mineral concentrations are higher in Cauliflower of Sargodha region as compared to Soon Valley region. The difference of concentration is attributed to different quality of water used for irrigation purpose in the two selected regions. Regarding the mineral contents of Soon valley region, highest concentration was found for Ni (0.923 mg/kg) and lowest concentration was of Cd (0.049 mg/kg). While in Sargodha region, highest concentration was found for Pb (1.965 mg/kg) and lowest concentration was of Cd (0.061 mg/kg). The magnitude of minerals of Soon Valley region were of the order Cd < Co < Cu < Cr < Pb< Zn < Ni. The magnitude of minerals of Sargodha region was found to be Cd < Co < Cu < Cr < Zn < Ni < Pb. The accumulation of minerals in vegetables collected from Sargodha region is majorly due to irrigation by contaminated water usually.

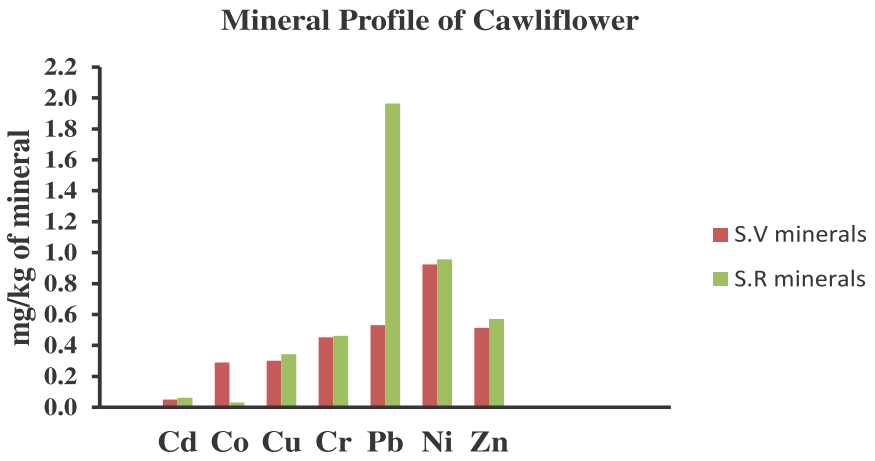


Figure 2. Minerals Profile of different metals

The Concentration of Pb was found to be (1.965 mg/kg) in Sargodha region and (0.531 mg/kg) in Soon valley region. According to Sharma *et al*. (2005) and Muchuweti *et al*. (2006) the concentration of Pb in vegetables collected from polluted waste water area exceeded the safety limits (2.5 mg/kg) and (2 mg/kg) respectively. The Concentration of Cu was found to be (0.343 mg/kg) in Sargodha region and (0.301 mg/kg) in Soon valley region. In polluted areas of Varanasi, India, the concentration of copper (2.25-5.42 mg/kg) was observed within safe limits (Tandi *et al*., 2005). The Concentration of Cr was found to be (0.461 mg/kg) in Sargodha region and (0.452 mg/kg) in Soon valley region. And chromium concentration was within safety limit in vegetables grown in industrial area (Muchuweti *et al*., 2006). The Concentration of Cd was found to be (0.061 mg/kg) in Sargodha region and (0.049

mg/kg) in Soon valley region. Various vegetables (cucumber, tomato, green pepper, lettuce, parsley, onion, bean, eggplant, pepper mint, pumpkin and okra) from Turkey were analyzed and higher content of Cd (0.24–0.97 mg/kg) injurious to human health was observed (Demirezen *et al*., 2006).Our present study showed the both cauliflower samples to be the least accumulator of Cd.

Table 6. Determination of reducing power

Sample Type	Concentration (mg/mL)	Absorbance (nm)	Reducing Power (mg/mL)
S.V 80% Methanol	1	0.444	1.034 ± 0.002
	1.5	0.471	0.155 ± 0.003
	2	0.491	1.934 ± 0.004
	2.5	0.512	0.233 ± 0.005
	3	0.554	3.140 ± 0.003
S.V 100% methanol	1	1.082	0.991± 0.004
	1.5	1.252	1.434± 0.003
	2	1.542	2.18 ± 0.001
	2.5	1.616	2.382 ± 0.003
	3	1.862	3.022 ± 0.005
S.V Distilled water	1	1.006	0.871 ± 0.003
	1.5	1.164	1.79 ± 0.001
	2	1.182	1.880 ± 0.002
	2.5	1.264	2.360 ± 0.002
	3	1.39	3.080 ± 0.002
S.R 80%	1	0.649	1.090 ± 0.002
	1.5	1.692	1.480± 0.003
	2	0.742	1.920 ± 0.003
	2.5	0.791	2.36 ± 0.003
	3	0.88	3.160 ± 0.003
S.R 100%	1	0.498	0.790 ± 0.002
	1.5	0.556	0.550 ± 0.005
	2	0.582	1.69 0± 0.003
	2.5	0.616	2.090± 0.003
	3	0.629	2.620 ± 0.004
S.R Distilled water	1	0.401	0.95 ± 0.003
	1.5	0.442	1.67 ± 0.002
	2	0.451	1.83 ± 0.002
	2.5	0.492	2.550 ± 0.004
	3	0.512	3.010 ± 0.004

Table 7. Antibacterial activity of different extracts of Cauliflower

Solvents	Antibacterial activity (mm) of different thyme extracts against four bacterial species			
	Bacillus subtilus	***Staphylococcus aureus***	***Salmonella typhi***	***Escherichia coli***
	Soon Valley Cauliflower			

100% methanol	13.56 ± 0. 49[a]	12.26 ±1.76[a]	8.166±0.15[a]	18.23± 0. 20[a]
80% methanol	11.23 ± 0.20[b]	8.22 ± 0.25[b]	11.26±0.25[b]	15.46 ± 0.20[b]
Distilled water	9.5 ± 0. 25[c]	7.30 ± 0. 10[c]	8.59±0. 10[c]	11.37 ± 0. 43[c]
100% methanol	**Sargodha Region Cauliflower**			
	19. 56 ± 0.41[a]	18.27 ± 0.15[a]	13.5 ± 0.47[a]	21.81 ± 0.27[a]
80% methanol	15.66 ± 0.41[b]	14.36 ± 0.15[b]	11.96± 0.20[b]	17.47 ± 0.25[b]
Distilled water	10.91 ±0.15[c]	8.5 ± 0. 13[c]	8.49±0.15[c]	14.88 ±0.30[c]
Ciprofloxacin	15.2 ± 0.2[d]	10.21 ± 0.32 [d]	11.63±0.15[d]	12.37 ±0.25[d]

The Concentration of Zn was found to be (0.572 mg/kg) in Sargodha region and (0.513 mg/kg) in Soon valley region. When various vegetables (cucumber, tomato, green pepper, lettuce, parsley, onion, pepper mint, pumpkin and okra) were analyzed it was observed that the Zn concentration (3.56–4.592 mg/kg) was within the recommended international standards (Demirezen *et al*., 2006). The Concentration of Ni was found to be (0.957 mg/kg) in Sargodha region and (0.923 mg/kg) in Soon valley region. The Concentration of Co was found to be (0.312 mg/kg) in Sargodha region and (0.289mg/kg) in Soon valley region. According to survey report of different fruits and vegetables in Egypt Pb, Co, Cu and Ni were observed with high values (Radwan *et al*., 2006).

3.8. Determination of Biological Activity

The values of antibacterial activity of soon valley Cauliflower and Sargodha valley Cauliflower against *Bacillus subtilus*, *Staphylococcus aureus, Salmonella typhi* and *Escherichia coli* ranged from 9.1-29.46 mm of dry weight (Table 7). The maximum value was observed for 100% methanol (21.81 mm) Sargodha region Cauliflower extract against *E. coli* while minimum was observed for distilled water (9.1 mm) of Soon valley Cauliflower against *Staphylococcus aureus*. The antibacterial activity values for soon valley Cauliflower were in range of: 8.16-18.23 for 100% methanol, 8.22-15.46 for 80% Methanol and 7.30-11.37 for distilled water and for Sargodha region cauliflower were in range of: 13.5-21.81 for 100% methanol, 11.96-17.47 for 80% methanol and 8.5-14.88 for distilled water. Among the extraction solvents, overall the order of solvents for antibacterial activity against selected microorganisms was: 100% methanol> 80% methanol >distilled water showing significant ($p < 0.05$).From above presented results, it is concluded that Sargodha Region Cauliflower showed greater antibacterial activity as compared to Soon Valley Cauliflower against selected bacterial strains. These results are also comparable to those reported by (Khalid *et al*., 2011) that Cauliflower has antimicrobial activity.

Conclusion

The study showed that the climatic and topographical changes, and variation in the composition of ground water and soil conditions affect the antioxidant attributes, phenolic acids composition, biological activities and minerals profiling of the cultivated crop, which here in the study is cauliflower. Although the extract quality greatly depends upon the solvent extraction system used, but the values of TPC (Total phenolic content), TFC (total flavonoid content), individual profiling of phenolic acids, reducing power, DPPH (2,2-diphenylpicrylhydrazyl) radical scavenging and mineral profiling assay greatly differ depending upon the area of the plant cultivation, which ultimately is linked to diverse climatic and topographical variations. Study indicates that Cauliflower from Soon valley has more antioxidant activity and fewer amounts of heavy metals as compared to Sargodha region. Moreover, the antimicrobial activity was found to be greater in Sargodha region Cauliflower. Cauliflower from Sargodha region might have higher antimicrobial activity due to greater minerals content of heavy metals, probably due to relatively polluted environment.

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