Journal of Medicinal Plants Research Vol. 6(47), pp. 5757-5762, 10 December, 2012
Available online at http://www.academicjournals.org/JMPR
DOI: 10.5897/JMPR10.022
ISSN 1996-0875© 2010 Academic Journals

Full Length Research Paper

Minerals, proximate composition and their correlations of medicinal plants from Jordan

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Accepted 11 June 2010

Ten medicinal plants (*Corianderum sativum*, *Hibiscus sabdariffa*, *Lepidium sativum*, *Nigella sativa L.*, *Petroselinum crispum, Salvia officinalis*, *Saponaria officinalis*, *Thymus capitatus*, *Origanum majorana, Trigonella foenum–graecum*) were subjected to proximate and mineral analysis. Results showed that chemical composition of the investigated medicinal plants varied significantly. Protein (5.4 %) in *T. foenum– graecum*, fat (43.8%) in *N. sativa*, fiber (48.6%) in *L. sativum* and carbohydrates (65%) in *H. sabdariffa*. The highest ash content (17.5%) was found in *P. crispum.* Dry matter content ranged between 82.2 (*P. crispum)* and 97.2% (*N. sativa*). Mineral content found to vary significantly. Appreciable amounts of Ca, K, Na, Mg and P were found, whereas Fe, Cu, Mn and Zn found in trace amounts in all plants. The correlation values were positively significant between fat and Zn (r = 0.56), dry matter and Fe (r = 0.58). High significant correlations were also found between crude protein and fat (r = 0.40), dry matter and fiber (r = 0.48) and ash and carbohydrates (r = 0.47).

Key words: Composition, minerals, medicinal plants.

INTRODUCTION

Recently, increasing demand on both nutritional and health foods with better nutraceutical, pharmaceutical, nutritional and functional properties have been studied extensively. Many wild medicinal plants are now recognized. In the past, medicinal plants have been used with multi-functional properties including medical usage, functional food and nutraceutical food components. Health effects of medicinal plants have been associated with it's consumption of active compounds such as volatile oils, peptides and phenolic compounds that lead to decrease risk of cardiovascular disease, antiviral activity, antibacterial activity, antifungal activity, laxative effect and anti-inflammatory (Shahidi and Naczk, 2004). Large number of medicinal plants species were identified in Jordan, a total of 485 species belonging to 330 genera and 99 families which are distributed all over the country from the eastern desert to the western highlands and from the semiarid north to the extremely arid south were reported (Oran et al., 1994). These are herbs, shrubs or trees and comprise 25% of the total flora in Jordan and are used as source of medicinal products (folk medicine) either by native people or at industrial scale (Irani and Johnson, 1998). *Corianderum sativum*, *Hibiscus sabdariffa*, *Lepidium sativum*, *Nigella sativa L.*, *Petroselinum crispum, Salvia officinalis*, *Saponaria officinalis*, *Thymus capitatus*, *Origanum majorana, Trigonella foenum–graecum* play a preventive role in the development of many diseases.

Proximate analysis of edible fruit and vegetables plays a crucial role in assessing their nutritional significance (Pandy et al., 2006). The mineral elements contained in those medicinal plants are very important in human nutrition. Calcium, potassium, magnesium and nitrogen in plant samples are required for repair of worn out cells, strong bones and teeth in humans, building of red blood cells and for body mechanisms (WHO, 1996). The high level of these elements shows that the leaves of the plants could provide alternative source of calcium and potassium in diet. Medicinal plants provide dietary supplements and some may promote bowel regularity and enhance frequent waste elimination, including bile

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acids. Fiber has a physiological effect on the gastrointestinal function of promoting the reduction of tracolonic pressure which is beneficial in diverticular disease. Fiber also has a biochemical effect on the absorption and re-absorption of bile acids and consequently the absorption of dietary fats and cholesterol (Edeoga et al., 2006).

Jordan has been known as a biodiversity environment that is rich with wild plant species. Traditionally, wild plants were recognized for medicinal uses in Jordan and Mediterranean area due to several biological and pharmacological properties. Medicinal plants were commonly used as functional food in Jordan such as herbal tea, spices, food preservative and food ingredient. No information has been reported about the chemical composition of medicinal plants in Jordan and Mediterranean area. This study was carried out to evaluate the nutritional values of some Jordanian medicinal plants.

MATERIALS AND METHODS

Plant materials

Plant Materials were collected twice from different locations in Jordan. The species were identified by a plant taxonomist in the Department of Forestry. Plant species, local and family names and their parts used are shown in (Table 1). Plant materials were air dried for 7 days after rinsing under running water and washing with distilled deionized water to remove foreign materials. Whole plant samples were immediately dried in a conventional oven to constant weight at 100 °C for 24 h to determine the dry matter (DM) content. Dried samples were milled in a laboratory mill into powder and stored for further analysis at 5°C in polyethylene bags to avoid oxidation.

Chemical analysis

Protein, fat, fiber, ash, and moisture were determined and computed on dry weight basis according to AOAC (1990). The moisture content of samples was determined by drying the samples at 100°C until a constant weight was obtained. Dried samples were analyzed to determine the total nitrogen content using micro-Kjeldahl method. A conversion factor of 6.25 was used to calculate protein content. The ash content was determined by burning 1 g of oven-dried sample in a crucible in a muffle furnace at 550°C for 24 h. The total lipids were isolated from medicinal plants samples using the Soxhlet method. Crude fiber was measured by digestion with 1.25% sulphuric acid followed 1.25% of potassium hydroxide. While the carbohydrates content was determined by the difference of TS minus other solid components.

Minerals analysis

One gram of samples were ashed in a porcelain crucible, solubilized in 10 ml of 2 M HCl, quantitatively transferred into 25 ml volumetric flasks, and diluted to volume with deionized water. Ca, K, Na, Fe, Cu, Mg, Mn, Zn concentration in the investigated plants were determined using atomic absorption spectrophotometer using atomic absorption spectro-photometer ((pye Unicam model Sp9) (Ereifej et al., 1997). Phosphorous was determined according to Fisk and Subbarrow (1925) procedure. The averages were recorded and computed on dry weight basis.

Statistical analysis

The collected data were subjected to statistical analysis using the General Linear Model Procedure of Statistic Analysis System (SAS, version 8). The means were compared using the Least Significant Differences (LSD) at 0.05 level of significance.

RESULTS AND DISCUSSION

Table 2 shows the gross chemical composition of the medicinal plants. The protein contents of all medicinal plants varied significantly except for *N.sativa* and *P. crispum* that were not varied significantly. Protein contents were ranged from 0.9 to 5.4% in *S. officinalis* and *T. foenum-graecum*, respectively. The highest content of protein was obtained in *T. foenum-graecum* with a value 5.4% which is lower than that reported by El Nasri and El Tinay (2007). For *O. majorana*, *T. capitatus* and *S. officinalis*, the content of proteins obtained were more than those found in some members of the Lamiaceae family by Edeoga et al. (2006). Adanlawo and Ajibade (2006) reported that the protein content in H. sabdariffa was lower than values reported in the current investigation. This suggests that *T. foenum-Graecum, L. sativum* and *N. sativa* may be used to fortify food product to improve the contents of protein in bakery products. For contents, the values varied significantly among all medicinal plants. However there are no significant differences in fat content between either *S. officinalis* (0.9%) and *H. sabdariffa or C. sativum* and *P. crispum* (1.7%). The contents of fat in the investigated medicinal plants varied significantly and ranged from 0.7 for *S. officinalis* to 43.8% for *N. sativa*. Cheikh-Rouhou et al. (2007) reported that the fat content was 40.4% in *N. sativa*. With *H. sabdariffa*, the fat content was slightly higher than that reported by Adanlawo and Ajibade (2006).

Results showed a lower value of fat content (5%) in *T. foenum-graecum* as compared to the value reported by El Nasri and El Tinay (2007). For the *O. majorana* and *T. capitatus*, the fat contents were in agreement (2.5 and 4.2%, respectively) with those reported by Edeoga et al. (2006). Whereas the content of fat in *S. officinalis* and *L. sativum* were slightly higher values (12.8 and 19.9%, respectively) than that reported previously by Govikavi et al. (2004). Obtained results suggested that the *N. sativa* and *L. sativum* is good emulsifier and foaming agents in bakery, bread, and ice cream industry due to the high and rich source of unsaturated fatty acids content. The content of fiber in the all medicinal plants varied significantly and ranged from 10 to 48.6% for *C. sativum* and *L. sativum*, respectively. Results revealed the higher content of fiber in *H. sabdariffa* (15.6%) as compared to that reported by Adanlawo and Ajibade (2006). For *T.*

Table 1. Medicinal plants from Jordan.

Plant scientific name	Family name	English name	Plant part used
Corianderum sativum	Umbelliferae	Coriander	Whole plant
Hibiscus sabdariffa	Malvaceae	Karkade	Petals
Lepidium sativum	Cruciferae	Cress	Seeds
Nigella sativa L.	Ranunclaceae	Black cumin	Seeds
Origanum majorana	Labiatae	Origano	Leaves
Petroselinum crispum	Umbelliferae	Parsley	Whole plant
Salvia officinalis	Labiatae	Meryamiah	Leaves
Saponaria officinalis	Caryophyllaceae	Bouncing bet	Roots
Thymus capitatus	Labiatae	Thyme	Leaves
Trigonella foenum- graecum	Leguminosae	Fenugreek	Seeds

Table 2. Chemical composition of the investigated medicinal plants[a].

Medicinal plant	Protein (%)	Fat (%)	Fiber (%)	Carbohydrates (%)	Ash (%)	DM (%)
Corianderum sativum	3.5^{d}	1.7^{g}	10.0^{d}	63.0^{a}	17.3^{a}	*89.2^{d}
Hibiscus sabdariffa	1.8^{e}	0.9^{h}	15.6^{cbd}	65.0^{a}	11.8^{c}	93.2^{b}
Lepidium sativum	4.8^{b}	19.9^{b}	48.6^{a}	19.5^{e}	5.9^{e}	93.6^{b}
Nigella sativa L.	4.3^{c}	43.8^{a}	11.7^{cd}	35.0^{ced}	4.6^{fe}	97.2^{a}
Origanum majorana	2.0^{e}	2.5^{f}	26.7^{cb}	55.7^{ab}	14.0^{b}	93.2^{b}
Petroselinum crispum	4.1^{c}	1.7^{g}	14.0^{cd}	58.4^{ab}	17.5^{a}	82.2^{e}
Salvia officinalis	1.3^{f}	12.8^{c}	31.0^{b}	43.1^{bcd}	9.1^{d}	93.6^{b}
Saponaria officinalis	0.9^{g}	0.7^{h}	47.9^{a}	33.0^{ed}	3.0^{cb}	88.8^{d}
Thymus capitatus	3.3^{d}	4.2^{e}	18.1^{cbd}	50.7^{abc}	2.2^{cb}	94.0^{b}
Trigonella foenum–graecum	5.4^{a}	5.0^{d}	26.6^{cb}	54.2^{ab}	3.9^{f}	90.9^{c}
LSD (P ≤ 0.05)	0.4	0.3	16.3	16.5	1.8	1.5

Means within each column followed by the same letter(s) are not significantly different at p ≤ 0.05 according to LSD; a= values are average of two replicates, and computed on dry weight basis; DM= dry matter.

foenum-graceum, higher fiber content (26.6%) was obtained as compared to that reported by El Nasri and El Tinay (2007). However the fiber content of *P. crispum*, *O. majorana*, *T. capitatus* and *S. officinalis* was much higher (14.0, 26.7, 18.1 and 31.1%, respectively) than values reported by Alfawaz (2006). For Carbohydrate content, the values varied significantly and ranged from 19.5 (*L. sativum*) to 65.0% (*H. sabdariffa*). The highest content of carbohydrate was in *H. sabdariffa* (65%) which is lower than that reported by Adanalow and Ajibade (2006). While the content of carbohydrate in *T. foenum-graecum* (54.2%) was slightly higher than that reported by El Nasri and El Tinay (2007).

Ash content varied significantly and ranged from of 2.2 (*Thymus capitatus*) to 17.5% (*Petroselinum crispum*). The explanation for this variation is probably due to the environmental factors and botanical variation. Obtained results demonstrated that the content of ash in *O. majorana*, *T. capitatus* and *S.officinalis* were 14.0, 2.2 and 9.1%, respectively. Higher ash contents in *O. majorana*, *T. capitatus* and *S. officinalis* has been reported by Alfawaz (2006) and lower values have been found by Edeoga et al. (2006). For *H. sabdariffa*, the content of ash was slightly lower (11.8%) than that reported by Adanlawo and Ajibade (2006). While comparable values were obtained (3.9%) in *T. foenum-graecum* to that reported by El Nasri and El Tinay (2007). Significant variations in dry matter contents were found. The content of dry matter values ranged from 82.2 (*P. crispum)* to 97.2% (*N. sativa*). This variation was expected due to variation in plant species and growth stage (Peiretti and Gai, 2006). Dry matter contents in *H. sabdariffa* were comparable with values reported by Adanlawo and Ajibade (2006). Whereas the content of dry matter in *T. foenum-graecum* (90.9 %) was slightly lower than that reported by El Nasri and El Tinay (2007). For *O. majorana*, *T. capitatus* and *S. officinalis*, the contents of dry matter were comparable (93.2, 94.0 and 93.6 5, respectively) to that reported by Edeoga et al. (2006).

Data on minerals concentration are shown in Table 3. Calcium (Ca) content varied significantly and ranged from

Table 3. Minerals concentration in medicinal plants[a] (mg /100g).

Medicinal plant	Ca	K	Na	Fe	Cu	Mg	Mn	P	Zn
Corianderum sativum	64.8^{e}*	66.5^{d}	25.6^{c}	2.2^{ed}	0.2^{cd}	31.7^{d}	0.6^{d}	67.8^{c}	0.6^{c}
Hibiscus sabdariffa	97.9^{d}	88.0^{a}	4.4^{i}	1.9^{e}	0.1^{ed}	43.9^{c}	4.6^{a}	12.5^{e}	0.9^{e}
Lepidium sativum	8.2^{h}	85.3^{a}	12.4^{e}	1.1^{f}	0.1^{ed}	31.8^{d}	0.3^{f}	96.3^{ba}	1.0^{ba}
Nigella sativa L.	17.2^{g}	75.8^{c}	12.4^{j}	2.6^{d}	0.2^{b}	26.4^{e}	0.3^{f}	105.9^{a}	1.2^{a}
Origanum majorana	222.3^{b}	85.1^{ba}	11.1^{f}	5.1^{b}	0.2^{cb}	28.1^{e}	0.5^{e}	12.9^{e}	1.2^{a}
Petroselinum crispum	42.9^{f}	73.0^{c}	66.1^{a}	1.3^{f}	0.2^{cb}	46.1^{c}	0.8^{b}	70.7^{c}	0.8^{c}
Salvia officinalis	165.6^{c}	81.0 ^{b}	9.5^{g}	4.4^{c}	0.1^{ed}	59.8^{b}	0.3^{f}	9.2^{e}	0.6^{e}
Saponaria officinalis	241.6^{a}	34.2^{e}	22.4^{d}	15.7^{a}	0.1^{e}	10.3^{g}	0.5^{e}	10.2^{e}	0.7^{e}
Thymus capitatus	98.9^{d}	86.1^{a}	34.8^{b}	5.0^{b}	0.3^{a}	71.6^{a}	0.7^{c}	85.2^{bc}	0.8^{c}
Trigonella foenum-graecum	10.5^{h}	87.5^{a}	5.5^{h}	1.1^{f}	0.2^{cb}	13.6^{f}	0.2^{g}	41.2^{d}	1.0^{b}
LSD ≤ 0.05	5.2	4.23	0.8	0.5	0.1	2.6	0.1	17.9	0.1

Means within each column followed by the same letter(s) are not significantly different at p ≤ 0.05 according to LSD; A = Values are average of two replicates, and computed on dry weight basis.

8.2 (*Lepidium sativum*) to 241.6 mg /100g (*S. officinalis*). The contents of calcium in *O. majorana*, *T. capitatus* and *S. officinalis* were slightly lower (222.2, 98.9 and 165.6 mg /100 g, respectively) than values reported by Edeoga et al. (2006). However, the content of calcium was 12.9 mg /100 g in *H. sabdariffa* which was higher than that reported by Adanalow and Ajibade (2006) (97.9 mg /100 g). For potassium (K) content, the values varied significantly and ranged from 34.2 (*S. officinalis*) to 88.0 mg/100 g (*H. sabdariffa*). The content of potassium in *H. sabdariffa* was found to be higher (88.0 mg /100 g) than that reported by Adanalow and Ajibade (2006). While the contents of potassium in *O. majorana*, *T. capitatus* and *S. officinalis* were found to be lower (85.1, 86.1 and 81.0 mg/100) than that reported by Edeoga et al. (2006). The variation in potassium content might be due to environmental factors. Sodium (Na) values varied significantly and ranged from 4.4 in *H. sabdariffa* to 66.1 mg/100 g in *P. crispum*). Sodium contents in *H. sabdariffa* was lower (4.4 mg/100) than that reported by Edeoga et al. (2006). The Fe content varied significantly and ranged from 1.1 (*T. foenum-graecum, L. sativum*) to 15.7 mg / 100 g (*S. officinalis*).

The contents of copper (Cu) varied significantly and ranged from 0.1 (*H. sabdariffa, L. sativum, S. officinalis, S. officinalis*) to 0.3 mg/100 g (*T. capitatus*). Adanalow and Ajibade (2006) reported that the content of copper was 0.01 mg/100 g in *H. sabdariffa.* For the content of magnesium (Mg), the highest value was revealed in *T. capitatus* (71.6 mg/100 g), whereas the lowest value were obtained (10.3 mg/100g) in *S. officinalis*. The content of magnesium for *H.sabdariffa* was higher than those reported by Adanalow and Ajibade (2006). Manganese (Mn) content was found to vary and ranged from 0.2 *(T.foenum- graceum*) to 4.6 mg/100 g (*H. sabdariffa*).

High content of phosphorus (P) was found in the investigated medicinal plants and ranged from 9.2 (*S. officinalis*) to 105.9 mg/100 g (*N. sativa L*.). Adanalow and Ajibade (2006) reported higher values of phosphor in *H.sabdariffa* than values in the current investigation (12.5 mg/100 g). In 1980 the food and nutrition board considered Zinc (Zn) as an essential metal and a daily intake of 15 mg has been recommended for adults (Ereifej, 1997), results for the investigated plants (Table 3) showed levels of Zn ranging from 0.6 (*S. officinalis, C. sativum*) to 1.2 mg/100 g (*O. majorana, N. sativa)*. Revealed results suggested medicinal plants of Jordan as a rich source of proteins, carbohydrate, fat, fiber and minerals which are very important in human nutrition. Data on correlation coefficients are presented in Table 4, 5, and 6. Table 4 shows the correlation coefficients between proximate analysis values and mineral levels. Significant correlation coefficients were found between crude protein and Zn (r = 0.40), Na (r = 0.11), Cu (r = 0.38), K (r = 0.41) and P (r = 0.61). Fat content had high correlation coefficient with Zn (r = 0.56). While lower significant correlation coefficient with Cu (r = 0.1), K (r = 0.21) and P (r = 0.09) was obtained. Correlation coefficient was not significant between dry matter content and all minerals except the correlation coefficient for Ca (r = 0.42) and Fe (r = 0.59) and ash (r = 0.48) (Table 4). High correlation coefficient for ash and carbohydrates (r = 0.47), Na (r = 0.75) and P (r = 0.59) was found, on the other hand, a positive correlation coefficient values were found between ash and all the elements except for Zn (r = -0.46) and K (r = -0.24) (Table 4). The correlation coefficients between fiber content were positive for Ca (r = 0.29), Fe (r = 0.44) and Zn (r = 0.02) as compared to Mn, Mg, Na, Cu, K and P which was negatively correlated. Results showed positive correlation coefficients between carbohydrates and all the minerals except Fe (r = -0.24) and Zn (r = -0.29).

Table 5 shows the correlation coefficients between the

Table 4. Correlation coefficients between minerals and crude protein, fat, DM, ash, NDF, and carbohydrates of the investigated medicinal plants.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Protein	0.40	- 0.40	- 0.18	-0.19	-0.14	- 0.90	- 0.32	0.40	- 0.68*	- 0.14	0.11	0.38	0.41	0.61**
2. Fat		- 0.67	- 0.55	- 0.04	- 0.55*	- 0.43	- 0.28	0.56*	- 0.22	- 0.07	- 0.39	0.10	0.21	0.09
3. DM			- 0.09	0.48	0.06	0.42	0.05	- 0.40	0.58**	0.30	- 0.02	- 0.23	- 0.48	- 0.52*
4. Ash				- 0.40	*0.47	0.18	0.10	- 0.46*	0.00	0.25	0.75**	0.09	- 0.24	0.58**
5. NDF					- 0.78**	0.29	- 0.28	0.02	0.44	- 0.30	- 0.22	- 0.51*	- 0.31	- 0.47
6.Carbohydrate						0.06	0.49*	- 0.29	- 0.24	0.30	0.22	0.34	0.24	0.13
7. Ca							0.03	- 0.22	0.77**	- 0.02	- 0.07	- 0.21	- 0045*	- 0.58
8. Mn								- 0.11	- 0.16	0.19	- 0.14	- 0.18	0.20	- 0.17
9. Zn									-0.25	- 0.29	- 0.36	0.34	0.42	0.04
10. Fe										- 0.28	- 0.01	-0.22	0.82**	-0.48
11. Mg											0.34	0.39	0.46*	0.08
12. Na												0.25	- 0.22	0.68**
13. Cu													0.37	0.28
14. K														0.07
15. P														

** = Correlation is significant at the 0.01 level and * = Correlation is significant at the 0.05 level.

Table 5. Correlation coefficients of the chemical composition of the medicinal plants.

	2	3	4	5	6
1. Protein	0.40	- 0.40	- 0.18	- 0.19	- 0.14
2. Fat		- 0.67**	- 0.55*	- 0.04	- 0.55*
3. DM			-0.09	0.48*	0.06
4. Ash				-0.40	- 0.47
5. Fiber					- 0.78**
6. Carbohydrates					

** = Correlation is significant at the 0.01 level and * = Correlation is significant at the 0.05 level

chemical compositions of some medicinal plants grown under Mediterranean conditions. Highly significant correlation coefficients were found between crude protein and fat content (r = 0.40). Negative correlation coefficients were found between fat and dry matter, ash, fiber, and carbohydrate levels of the investigated plants. High correlation coefficients were found between dry matter and fiber content (r = 0.48). Fiber correlation coefficient (r = - 0.47) was negatively correlated with carbohydrates. Table 6 demonstrates the correlation

Table 6. Correlation coefficients between the minerals content of the medicinal plants.

Mineral (mg/ 100g db)	2	3	4	5	6	7	8	9
1. Ca	.03	- 0.22	0.77**	- 0.02	- 0.07	- 0.21	- 0.45*	- 0.58**
2. Mn		-0.11	-0.16	0.19	- 0.14	- 0.18	0.20	- 0.17
3. Zn			- 0.25	- 0.28	- 0.36	-.34	- 0.42**	- 0.04*
4. Fe				- 0.28	- 0.01	- 0.22	- 0.82**	- 0.48
5. Mg					0.34	0.39	0.46*	0.08
6. Na						0.25	- 0.22	0.68
7. Cu							0.37	0.28
8. K								0.07
9. P								

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level and dp = dry weight basis

coefficients among the minerals. Highly significant correlation coefficients were found between Ca and Fe (r = 0.77), Mg and K (r = 0.46), and Na and P (r = 0.68). Positive correlation coefficient was found between Mg and Na (r = 0.34), Cu (r = 0.39) and P (r = 0.08), Na and Cu (r = 0.25), Cu and k (r = 0.37) and Cu and P (r = 0.28).

Conclusion

The conclusion of this study shows that the correlation coefficient might be a useful evaluation tool for medicinal plant breeders when breeding for a single character. The past decade has witnessed a tremendous resurgence in the interest and use of medicinal plants products in Jordan. Nutritive compounds and major minerals were found in some of the medicinal plants, those compounds can be used by the pharmaceutical industries as well as in food supplements. Medicinal plants have been found to be used in the food industry as enhancer for nutraceutical, functional and nutritional properties of food and their products.

ACKNOWLEDGEMENT

The authors acknowledge the financial support for this research by the Ministry of Planning and International Cooperation/ Medicinal Plants Program administrated by Dr. Kamal Khairalla. The authors also extend their appreciation to the Dean of Scientific Research at King Saudi University for funding the work through the research group project no RGP-VPP-193)

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