Turkish Journal of Agriculture - Food Science and Technology, 10(6): 1125-1129, 2022
DOI: https://doi.org/10.24925/turjaf.v10i6.1125-1129.4921

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Assessment of The Phenolic and Flavonoid Content in Certain Globe Artichoke (*Cynara scolymus* L.) Cultivars Grown in Northern Tunisia[#]

Riadh Ilahy[1,a,*], Imen Tlili[1,b], Thouraya R'him[1,c], Zouhair Rached[2,d], Kamel Arfaoui[3,e], Zoltàn Pék[4,f], Marcello Salvatore Lenucci[5,g], Hussein Daood[4,h], Lajos Helyes[4,i]

[1]*Department of Horticultural Crops, National Agricultural Research Institute of Tunisia, University of Carthage, Ariana, Tunisia*
[2]*Laboratory of Rural Economy, National Agricultural Research Institute of Tunisia, University of Carthage, Ariana, Tunisia*
[3]*Groupement Interprofessionnel des Légumes, GIL, Tunisia*
[4]*Institute of Horticultural Science, Szent István Campus, Hungarian University of Agriculture and Life Sciences, 2100 Gödöllő Páter K. st.1, Hungary*
[5]*Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università del Salento (DiSTeBA), Via Prov.le Lecce-Monteroni, 73100 Lecce, Italy.*
[*]*Corresponding author*

ARTICLE INFO

[#]*This study was presented as an online presentation at the 2nd International Journal of Agriculture - Food Science and Technology (TURJAF 2021) Gazimağusa/Cyprus*

Research Article

Received : 01/12/2021
Accepted : 28/01/2022

Keywords:
Total phenolics
Artichoke
Flavonoids
Quality
Cynara scolymus L

ABSTRACT

Artichoke (*Cynara scolymus* L.) is a worldwide popular horticultural crop. Interest in assessing bioactive compounds with potential health benefits in artichoke is increasing. Therefore, in this study, the variability in total phenolic and flavonoid contents of six artichoke cultivars, including five purple namely Brindisie, Opal, Conserto, Romanesco and Rouge de France as well as an ordinary white artichoke variety were investigated. The results showed significant differences in total phenolic and flavonoid contents between artichoke cultivars. Total phenolic content ranged from 17.31 mg GAE/ g DW in the white artichoke variety to 21.31 mg GAE/g DW in Romanesco. Flavonoid content ranged from 4.51 mg RE/g DW in white artichoke to 7.06 mg RE/g DW in Rouge de France. Therefore, the highest total phenolic content was shown by Romanesco. However, the highest flavonoid content was recorded for both Opal and Rouge de France. This study demonstrates the importance of genotypic variability in shaping the levels of total phenolic and flavonoid, emphasizing the need to evaluate artichoke biodiversity in order to improve its nutritional value and to contribute towards increasing the intake of antioxidants.

[a] *bn.riadh@gmail.com* *https://orcid.org/0000-0001-9405-3098*
[b] *imen_tlili2008@yahoo.fr* *https://orcid.org/0000-0002-7132-1915*
[c] *thouraya.rhim@yahoo.fr* *https://orcid.org/0000-0001-5912-9982*
[d] *rached_zouhair@yahoo.fr* *https://orcid.org/0000-0002-9240-6475*
[e] *arfaouikamel808@yahoo.fr* *https://orcid.org/0000-0001-7951-8221*
[f] *pek.Zoltan@uni-mate.hu* *https://orcid.org/0000-0001-9767-8800*
[g] *marcello.lenucci@unisalento.it* *https://orcid.org/0000-0002-6493-9549*
[h] *hdaood682@gmail.com* *https://orcid.org/0000-0001-6004-7650*
[i] *helyes.lajos@uni-mate.hu* *0000-0001-7365-8653*

Introduction

Artichoke (*Cynara scolymus* L.) is a worldwide popular horticultural crop. The world production of artichoke is 1.6 M tons in 2019 (FAO Stat, 2021) with Italy, Spain and France as world leader producers. In Tunisia, artichokes are widely cultivated for its inflorescence called capitula or heads, consumed fresh, canned or pickled. The production is around 28000 tons reserved mainly for fresh market and for exportation opportunities when prices are suitable. The artichoke is characterized by a low fat and a high minerals (potassium, sodium, phosphorus) content, vitamin C, fibers, polyphenols, flavones, inulin and hydroxycinnamate, derivatives of caffeoylquinic acid (Ceccarelli et al., 2010; Pandino et al., 2011). Artichoke leaves and heads are characterized by a high content of polyphenol, inulin, fiber and mineral elements (Lattanzio et al. 2009; Marques et al., 2017). Artichoke leaf has been used in traditional and folk medicine for the treatment of hepatic diseases, jaundice, dyspepsia, chronic albuminuria, postoperative anemia, and liver tonic diseases (Dranik et al., 1996; Galvano, 1984; Lattanzio et al., 2009; Sonnante et al., 2002).

Phenolic compounds are among the most important groups of secondary metabolites in plants alongside terpenoids and alkaloids. Chemically, flavonoids are formed by two benzene rings linked by an oxygenated heterocycle (Ilahy et al., 2018; Sevindik et al., 2017; Mohammed et al., 2020). Flavonoids can occur as

glycosides containing a sugar substituent (rutinose, rhamnose, glucose, galactose and arabinose) or as aglycones (without a sugar substituent). These molecules serve important functions in plants. In addition, they are attracting increasing attention for their antioxidant, anti-inflammatory, antimicrobial properties and their possible effects in the prevention of certain types of cancers and other severe human disorders. Their role as natural antioxidants helps prevent cell oxidation and thus fight against cell ageing. This is essential in the prevention and treatment of cancer (Kına et al., 2021; Korkmaz et al., 2021; Mohammed et al., 2021). The main phenolic compounds in artichoke are the derivatives of caffeic acid which include the derivatives of caffeoylquinic acid, chlorogenic acid is the most abundant followed by 1,5-O-dicaffeolylquinic acid and 3,4-O-dicaffeolylquinic acid as acid based on the total content of dicaffeoylquinic acid (Lattanzio et al. 2009; Petropoulos et al., 2018). In addition, the content of 1,3-O dicaffeoylquinic acid (cynarin) in the methanolic extract of artichoke is very low, the majority is located in the pulp and leaves. although the leaves and dry stems of artichoke contain this pigment (Lattanzio et al., 2009). The phenolic compounds listed above have an important activity of scavenging and neutralizing free radicals at reactive oxygen species and form a shield against oxidative damage to biological molecules such as lipids, proteins and DNA (Dangles and Dufour, 2008; Ceccarelli et al., 2010; Uysal et al., 2021).

Flavonoids are responsible for the varied colour of flowers and fruits and are an important source of antioxidants in our diet. They are a subclass of polyphenols with more than 6000 compounds already detected in plants. Flavonoids are compounds with strong antioxidant properties responsible for the colour of food with beneficial health effects for the heart, arteries, liver, immune system, muscle tissue and nervous system (Ilahy et al., 2018)

In artichoke, phenols such as the flavones apigenin, luteolin and anthocyanidins such as cyandin, peonidin and delphinidin have been isolated only from artichoke flower heads (Lattanzio et al., 2009) in addition to Outer bracts and artichoke flower heads can be used for the extraction of inulin which is a fructose polysaccharide belonging to the fructan family (Lopez-Molina et al., 2005). Considering the bibliographic data above and the importance of these bioactive compounds, we propose to determine the content of total polyphenols and flavonoids in six varieties of artichoke cultivated in Tunisia, Brindisie, Opal, Conserto, Romanesco, Rouge de France and an unknwon white artichoke variety.

Materials and Methods

Vegetal Materials

The trials were conducted in 2017 at the research and experimentation station of the Potato and Artichoke Technical Center (CTPTA), Mannouba, Tunisia. A total of six artichoke varieties including five purple type (Opal, Conserto, Brindisi, Rouge de France and Romanesco) and one white type variety (white artichoke) were used in this trial (Figure 1).

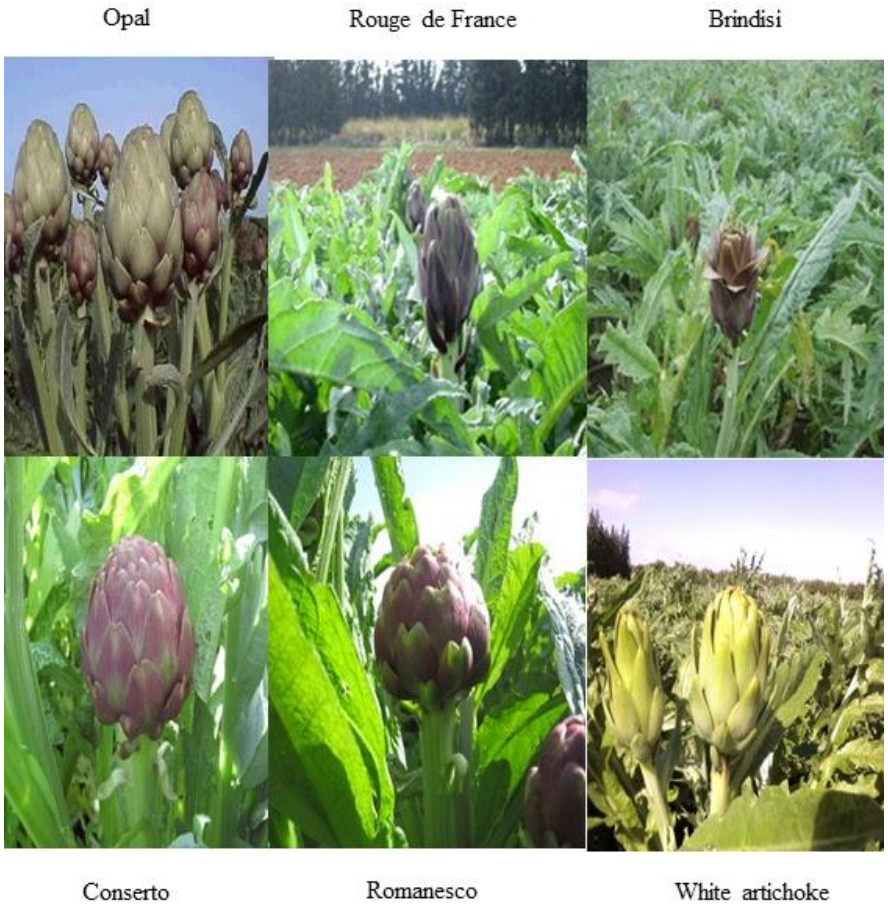

Figure 1. globe artichoke cultivars used in the the present trial

Polyphenol Content Determination

Total phenols were extracted as described by Martínez-Valverde et al. (2002) on triplicate independent aliquots (0.3 g) of artichoke samples. Briefly, 5 mL of 80% aqueous methanol and 50 µL of 37% HCl were added to each sample. The extraction was performed at 4°C, for 2 h, under constant shaking (300 rpm). Samples were centrifuged at 10000 g for 15 min. The total phenols assay was performed by using the Folin-Ciocalteu reagent as described by Spanos and Wrolstad (1990) on triplicate 50 µL aliquots of the supernatant. The absorbance was read at 750 nm using a Beckman DU 650 spectrophotometer (Cecil Instruments Ltd., Cambridge, UK). The linear reading of the standard curve was from 0 to 300 µg gallic acid equivalent/mL. The results were expressed as mg gallic acid equivalent per kg of DM (mg GAE/g DM).

Flavonoid Content Determination

The flavonoid content was determined according to the method of Zhishen et al. (2000) on three replicates of aliquots of the dry matter (0.3 g). Fifty microliters of the methanolic extract was used for the determination of flavonoids. The samples were diluted with distilled water and 5% $NaNO_2$ was added. After 5 min, 60 µL of 10% AlCl3 were added and finally 200 µL of NaOH were added after 6 min. The absorbance was read at 510 nm by a spectrophotometer (Beckman DU 650) and the flavonoid content was expressed as mg rutin equivalent (RE) per g DW (mg RE/g DW).

Statistical Analysis

The basic trial plots were distributed according to a randomized experimental design in three whole blocks. Analysis of variance was performed according to the General Linear Models (GLM) procedure developed by the Institute for Statistical Analysis Systems (SAS, V6.0, Cary, NC). Means and standard errors were calculated. The LSD test was also applied to test for significant differences between the means with a confidence level of 95%.

Results and Discussion

The total polyphenol contents of the inflorescence receptacle fraction of the studied artichoke varieties are presented in Figure 2. The total phenol content varied significantly from 17.31 mg GAE/g DW in white artichoke cv. to 21.31 mg GAE/g DW in cv. Romanesco. Cv. Rouge de France showed a total phenol content similar to that of cv. Brindisi. The values obtained are in agreement with those of several authors. Lambardo et al. (2012) studied the variation of polyphenol content in a collection of artichoke germplasms and found significant variation between the 17 varieties studied. Pandino et al. (2012) determined the polyphenol contents in different artichoke clones cultivated in Italy at different localities and revealed that the content of polyphenol content in inflorescence receptacle fraction varied from 2.7 mg/g DW in clone 5 to 9.37 mg/g DW in clone 2. Khaldi et al. (2013) studied the polyphenol composition in different fractions of the Tunisian population of Cynara cardunculus. The authors found that all organs showed a high polyphenol content ranging between 8.5 and 23.25 mg GAE/g DW. Lavecchia et al. (2019) reported similar values in stems and bracts of cultivar Romanesco with 51.10 mg GAE/g 24.58 mg GAE/g respectively. Abd El-Aziz et al. (2021) Total phenolic content in artichoke extract was 193.63 µg/g dry extract. Petropoulos et al. (2018) found that total phenolic compounds content and phenolics composition differed between the various *Cynara cardunculus* L. plant parts, with heads and leaf blades having higher content than midribs and petioles. Additionally the authors revealed that heads and leaf midribs and petioles consisted mainly of phenolic acids (5-*O*-caffeoylquinic and 3,5-*O*-dicaffeoylquinic acid), with flavonoids being detected in lower amounts.

The flavonoid contents of the studied artichoke varieties are presented in figure 3. The flavonoid content varied significantly from 4.51 mg RE/g DW in white artichoke cv. to 7.06 mg RE/g DW in Rouge de France. Cv. Rouge de France variety showed a similar flavonoid content to that of cv. Opal. Cvs. Romanesco, Brindisie, Conserto varieties also showed statistically similar flavonoid content to that of the White artichoke cv. The values obtained are in agreement with those of Khaldi et al. (2013) who reported flavonoid contents ranging from 7.46 to 12.75 mg CE/g DW in different organs of the Tunisian population of cynara cardunculus. Abd El-Aziz et al. (2021) reported that flavonoid content in artichoke extract was 71.43 µg/g dry extract. Ruiz cano et al. (2014) reported that total phenolic and flavonoid contents ranged from 153 to 729 µmol gallic acid equivalents and from 6.9 to 19.2 µmol quercetin equivalents equivalents per gram of dry matter, respectively.

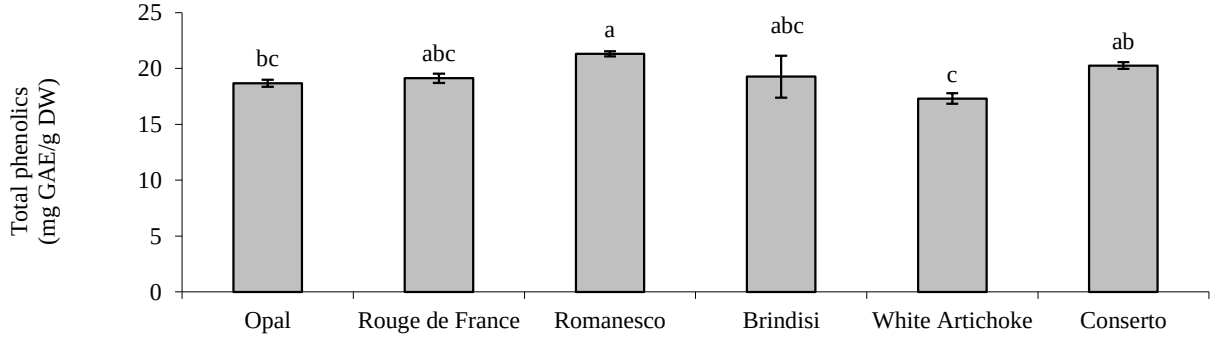

Figure 2. Total phenolics (mg GAE/ g DW) in the inflorescence receptacle fraction of the studied artichoke cultivars

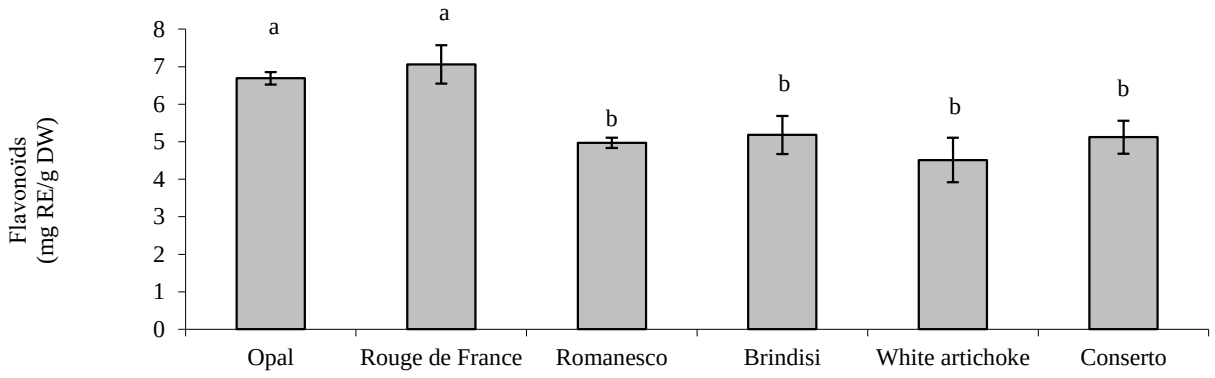

Figure 3. Flavonoids content (mg RE/g DW) in the inflorescence receptacle fraction of the studied artichoke cultivars

Conclusion

This study confirmed the important role of the genotype in determining the functional quality of artichoke. In addition, the present study highlights the promising use of the cvs Opal and Rouge de France for their very high polyphenol and flavonoid contents as high antioxidant content genotypes which can be used in further genetic improvement programs. The variability detected between the artichoke varieties studied showed the existence of unexploited variability in artichoke for these traits and express the need to further assess other genotypes in order to select elites cvs for breeding programs aiming to improve the functional quality in artichokes.

Acknowledgements

This study was kindly supported by Agricultural Research and Higher Education Institution (IRESA).

References

Abd El-Aziz NM, Awad OME, Shehata MG, El-Sohaimy SA. 2021. Antioxidant and anti-acetylcholinesterase potential of artichoke phenolic compounds. Food Bioscience, 41: 101006. https://doi.org/10.1016/j.fbio.2021.101006

Ceccarelli N, Curadi M, Picciarelli P, Martelloni L, Sbrana C, Giovannetti M. 2010. Globe artichoke as functional food. Mediterr. J. Nutr. Metab., 3: 197-201. https://doi.org/10.1007/s12349-010-0021-z

CTPTA. 2013. Centre Technique de la Pomme de Terre et de l'Artichaut. www.ctpta.tn

Dangles O, Dufour C. 2008. Flavonoid-protein binding process and their potential impact on human health. In, F. Daayf, & V. Lattanzio (Eds.). Recent advances in polyphenol research. Wiley-Blackwell, Oxford, UK. https://doi.org/10.1002/9781444302400.ch3

Dranik LI, Dolganenko LG, Slapke J, Thoma N. 1996. Chemical composition and medical usage of *Cynara scolymus* L. Rastit. Resur. 32: 98–104.

FAO. 2021. Food Agriculture Organisiation. www.fao.org

Galvano G. 1984. The use of bracts of artichoke (*Cynara scolymus* L.) in the feeding of cattle. Dev. Food Sci. 9 : 173–180.

Ilahy R, Siddiqui MW, Tlili I, Montefusco A, Piro G, Hdider C, Lenucci MS. 2018. When color really matters: horticultural performance and functional quality of high-lycopene tomatoes. Critical Reviews in Plant Sciences, 37(1): 15-53.484-492.https://doi.org/10.1080/07352689.2018.1465631

Khaldi S, Khelifi M, El Gazzah M. 2013. Analysis of genetic variability in six Tunisian wild cardoon (Cynara cardunculus L. subsp. flavescens Wiklund) populations. Genetic resources and crop evolution, 60(2): 723-729. https://doi.org/10.1007/s10722-012-9869-8

Kına E, Uysal İ, Mohammed FS, Doğan M, Sevindik M. 2021. In-vitro antioxidant and oxidant properties of Centaurea rigida. Turkish Journal of Agriculture-Food Science and Technology, 9(10): 1905-1907.

Korkmaz N, Dayangaç A, Sevindik M. 2021. Antioxidant, antimicrobial and antiproliferative activities of Galium aparine. Journal of Faculty of Pharmacy of Ankara University, 45(3): 554-564.

Lattanzio V, Kroon PA, Linsalata V, Cardinali A. 2009. Globe artichoke: a functional food and source of nutraceutical ingredients. J. Funct. Foods, 1: 131-144. https://doi.org/10.1016/j.jff.2009.01.002

Lavecchia R, Maffei G, Paccassoni F, Piga L, Zuorro A. 2019. Artichoke waste as a source of phenolic antioxidants and bioenergy. Waste and Biomass Valorization, 10(10): 2975-2984. https://doi.org/10.1007/s12649-018-0305-y

Lopez-Molina D, Navarro-Martinez MD, Melgarejo FR, Hiner ANP, Chazarra S, Rodriguez-Lopez JN. 2005. Molecular properties and prebiotic effect of inulin obtained from artichoke (*Cynara scolymus* L.). Phytochemistry, 66: 1476-1484. https://doi.org/10.1016/j.phytochem.2005.04.003

Marques P, Marto J, Gonçalves LM, Pacheco R, Fitas M, Pinto P, Ribeiro H. 2017. *Cynara scolymus* L.: A promising Mediterranean extract for topical anti-aging prevention. Industrial Crops and Products, 109: 699-706. https://doi.org/10.1016/j.indcrop.2017.09.033

Martínez-Valverde I, Periago MJ, ProvanG, Chesson A. 2002. Phenolic compounds, lycopene and antioxidant activity in commercial varieties of tomato (*Lycopersicon esculentum*). Journal of the Science of Food and Agriculture. 82: 323–330. https://doi.org/10.1002/jsfa.1035

Mohammed FS, Kına E, Sevindik M, Doğan M, Pehlivan M. 2021. Antioxidant and antimicrobial activities of ethanol extract of Helianthemum salicifolium (Cistaceae). Indian Journal of Natural Products and Resources, 12(3): 459-462.

Mohammed FS, Günal S, Pehlivan M, Doğan M, Sevindik M, Akgül H. 2020. Phenolic content, antioxidant and antimicrobial potential of endemic Ferulago platycarpa. Gazi University Journal of Science, 33(4): 670-677.

Pandino G, Lombardo S, Mauro RP, Mauromicale G. 2012. Variation in polyphenol profile and head morphology among clones of globe artichoke selected from a landrace. Scientia Horticulturae, 138: 259-265. https://doi.org/10.1016/j.scienta.2012.02.032

Petropoulos SA, Pereira C, Ntatsi G, Danalatos N, Barros L, Ferreira IC. 2018. Nutritional value and chemical composition of Greek artichoke genotypes. Food chemistry, 267: 296-302. https://doi.org/10.1016/j.foodchem.2017.01.159

Sevindik M, Akgul H, Pehlivan M, Selamoglu Z. 2017. Determination of therapeutic potential of Mentha longifolia ssp. longifolia. Fresen Environ Bull, 26(7): 4757-4763.

Sonnante G, Pignone D, Hammer K. 2007. The domestication of artichoke and cardoon: from Roman times to the genomic age. Ann. Bot., 100: 1095-1100. https://doi.org/ 10.1093/aob/mcm127

Spanos GA, Wrolstad RE. 1990. Influence of processing and storage on the phenolic composition of Thompson Seedless grape juice. Journal of Agricultural and Food Chemistry. 38: 1565–1571. https://doi.org/10.1021/jf00097a030

Uysal İ, Mohammed FS, Şabik AE, Kına E, Sevindik M. 2021. Antioxidant and Oxidant status of medicinal plant Echium italicum collected from different regions. Turkish Journal of Agriculture-Food Science and Technology, 9(10): 1902-1904.

Zhishen J, Mengcheng T, Jianming W. 1999. The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chem, 64: 555-559. https://doi.org/10.1016/s0308-8146(98)00102-2