

The Mineralogical Composition of Samos Zeolitic Rocks and their Potential Use as Feed Additives and Nutrition Supplements

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Introduction and Objectives

Clinoptilolite of sedimentary origin with ≥ 80 wt% clinoptilolite, ≤ 20 wt% clay minerals, free of fibres and quartz, can be used as feed additive for all animal species (EU Regulation No 651/2013, Filippidis *et al.* 2016) and consequently as nutrition supplement. In humans and animals, inhaled or injected or swallowed, fibrous zeolites (mainly erionite and mordenite, and to a lesser extent roggianite and mazzite), as well as the SiO₂ minerals (quartz, cristobalite, tridymite), were found to be toxic, carcinogenic and highly pathogenic (Davis, 1993; Driscoll, 1993; Ross *et al.*, 1993).

The zeolitic rocks of Karlovasi-Marathokampos basin of Samos Island have been investigated for their mineralogy, petrology, geochemistry and possible industrial or environmental applications by many authors (e.g., Stamatakis, 1989; Pe-Piper & Tsolis-Katagas, 1991; Kantiranis *et al.*, 2004, 2011; Filippidis *et al.*, 2005; Mitiglaki *et al.*, 2015). Studies on the use of zeolitic rocks as feed additives in different animals show negative, neutral and positive effects on the production and quality of livestock products (e.g., Pond & Mumpton, 1984; Tserveni-Gousi *et al.*, 1997; Yannakopoulos *et al.*, 2000; Filippidis, 2010). In most studies the quality characteristics (EU Regulation No 651/2013, Filippidis *et al.*, 2016) of zeolitic rocks are not mentioned.

The aim of the present study is to determine the mineralogical composition by the X-Ray Diffraction (XRD) method, of fifteen samples of the zeolitic rocks from the Karlovasi-Marathokampos basin and evaluate their potential use as feed additives (in accordance with the EU Regulation No 651/2013) and as nutrition supplements (Filippidis *et al.*, 2016).

Results and Conclusions

Since the EU Regulation No 651/2013 concerns the clinoptilolite of sedimentary origin, the examined 15 samples can be grouped in those containing clinoptilolite and those without clinoptilolite.

Concerning the clinoptilolite-bearing rocks (Table 1), two samples (S1, S11) contain the fibrous zeolite mordenite (20-21 wt%), five samples (S7, S9, S10, S12, S13) contain < 80 wt% clinoptilolite (22-73 wt%), two samples (S4, S6) contain < 80 wt% clinoptilolite (17-33 wt%) and > 20 wt% clay minerals (27-42 wt%), one sample (S3) contains > 80 wt% clinoptilolite (86 wt%) and all samples contain quartz (2-5 wt%). Considering this mineralogical composition (Table 1), none of the clinoptilolite-containing rocks meet the requirements of the EU Regulation No 651/2013, and thus they cannot be used as feed additives for all animal species and consequently as nutrition supplements, since all of them contain 2-5 wt% quartz, two of them 20-21 wt% mordenite (fibrous zeolite), nine of them < 80 wt% clinoptilolite (17-73 wt%) and two of them > 20 wt% clay minerals (27-42 wt%).

Table 1. Mineralogical composition (wt%) of the clinoptilolite-containing rocks from Karlovasi-Marathokampos basin of Samos Island.

Sample	Clinoptilolite	Mordenite	Analcime	Phillipsite	Micas	Clay minerals	Quartz	Feldspars	Amorphous	Tot.
S1	59	21	-	-	4	8	5	3	-	100
S3	86	-	-	-	2	2	2	8	-	100
S4	33	-	-	-	9	27	5	18	8	100
S6	17	-	-	27	2	42	2	10	-	100
S7	54	-	-	-	10	4	2	30	-	100
S9	43	-	-	-	14	11	2	26	4	100
S10	67	-	-	-	7	4	2	20	-	100
S11	59	20	-	-	4	8	4	5	-	100
S12	73	-	-	-	11	4	5	7	-	100
S13	22	-	29	-	8	15	2	24	-	100

Concerning the non clinoptilolite-bearing rocks (Table 2), one sample (S15) contains 62 wt% the fibrous zeolite mordenite, three samples (S2, S5, S14) contain 29-70 wt% analcime, one sample (S8) contains 63 wt% chabazite, two samples (S5, S8) contain > 20 wt% clay minerals (23-29 wt%) and all samples contain quartz (2-6 wt%). Although the EU Regulation No 651/2013 refers to clinoptilolite of sedimentary origin, using the presence or absence of quartz and

fibrous minerals, we could evaluate the potential use of the non clinoptilolite-containing rocks, as feed additives and as nutrition supplements. Considering the mineralogical composition (Table 2), none of the mordenite, analcime and chabazite containing zeolitic rocks, can be used as feed additives for all animal species and consequently as nutrition supplements, since all of them contain 2-6 wt% quartz and one of them contains 62 wt% mordenite (fibrous zeolite).

Table 2. Mineralogical composition (wt%) of the non clinoptilolite-containing rocks from Karlovasi-Marathokampos basin of Samos Island.

Sample	Mordenite	Analcime	Chabazite	Micas	Clay minerals	Quartz	Feldspars	Amorphous	Tot.
S2	-	70	-	5	3	6	12	4	100
S5	-	29	-	6	29	3	30	3	100
S8	-	-	63	2	23	4	8	-	100
S14	-	68	-	4	2	6	11	9	100
S15	62	-	-	1	1	2	12	22	100

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