Austin Anthropology

Open Access

Austin Publishing Group

Special Article - Archaeology

Patterns of Human Diet in Eastern Sicily (Italy) during the First Millennium BCE

Rubini M[1,2]*, Libianchi N[1], Gozzi A[1] and Zaio P[1]
[1]Anthropological Service SABAP-LAZ, Italian Ministry of Culture, Italy
[2]Department of Archaeology, Foggia University, Italy
***Corresponding author:** Mauro Rubini, Anthropological Service SABAP-LAZ, Italian Ministry of Culture, Department of Archaeology, Foggia University, v Pompeo Magno 2, 00193 Rome, Italy

Received: November 04, 2020; **Accepted:** November 26, 2020; **Published:** December 03, 2020

Abstract

The aim of this study was to investigate and discuss the possible change in the diet patterns between two populations coming from Syracuse (east Sicily) during the first millennium BCE. One of these was the necropolis of the second generation of Greek colonizers (8th-7th century BCE) while the other was the Hellenistic necropolis (3rd century BCE) of the city. The study was conducted through the concentration of the strontium and zinc analysis for the reconstruction of the diet. Strontium and zinc are not essential in the living organism metabolism but they are concentrated in animals and plants with high variability depending by the trophic position of the organism. The results show which the two samples have both a similar diet, with cereal and vegetable intakes higher than animal protein ones. Furthermore, the older sample shows a great affinity with the diet patterns of Athens during the 9th-8th century BCE.

Introduction

The particular geographic location of the Sicily (Figure 1) give an important opportunity to understand the complex cultural and biological interactions existed between populations that lived in the Mediterranean basin. An important bio-cultural topic in the population history of this region was the Greek colonization of the island during the first millennium BCE.

This phenomenon produced important changes in the bio-cultural substratum of the Sicilian people [1]. The absorption process of the Greek culture was very deep and fast.

The massive Greek colonization was dated to the 8th century BCE. It played an important role in the cultural and human population development of the island, especially in the eastern side [2]. Under a biological perspective mixed marriages between indigenous and Greek individuals (mostly immigrants from island and coastal zones, such as Rhodes, Euboia, Achaia or Locris during the first phase of colonization) were the result of this process [1,2]. The revolutionary consequences of the Greek immigration on the indigenous substratum were clearly reflected in the material culture dated to the 8th-6th century BCE, characterized on one hand by massive imports of Greek pottery from several centres of production (such as Corinth) and on the other hand by local reproduction of the same products (Beatrice Basile, personnel communication). In the 7th-6th centuries BCE a cultural unity (a Graeco-Italic koinè) between the Sicily and southern-central Italy was established. During this period, the process of cultural development reached its peak. Punic and Elymian Sicily contributed also to this Hellenization process, although less intensely as it is clearly demonstrated by the Punic cemeteries of Palermo, Motya and Solunto (Beatrice Basile, personnel communication). At the end of the Peloponnesian Wars, when the relationship between the Sicilian Greek cities and their homeland was no longer so close, this process showed new and peculiar features derived from the necessity of re-population because of the conflict with Carthage and the presence of new non-Greek people and mercenaries. They were called with the name of neopolitai. Therefore, the Sicilian Greek world became more peculiar and autonomous from the homeland, and the Roman conquest of the island induced further immigrations and an enlargement of its genetic pool [1,3].

The aim of this study, which is part of a wider program on the population of the Mediterranean basin, was to investigate some nutritional aspects in two diachronic populations that lived in Syracuse during the first millennium BCE: the older represented by the Greek colonizers, the second by the inhabitants of the Hellenistic period of the city.

Material and Methods

The cemeteries under study are located in the limestone terraces along the Anapo River, west of Syracuse (Figure 2). The two-ostearchaeological samples are the following: the site of Viale Ermocrate (8th-6th century BCE) representing the second generation of Greek colonizers (Basile personal communication) and the other Contrada Fusco (3rd century BCE, Hellenistic Period).

The diagnosis of age at death and sex were effected according to the standard suggestions of Buikstra and Ubelaker [4]. The first sample (8th-6th century BCE) is represented by 7 males and 8 females, the second by 25 males and 19 females. The range of age at death considered in this study was 18-x years, where x>50 years.

Element analysis

Trace element analysis can give important information's on the dietary habits of past human populations [5-8]. The data obtained become even more important when they are compared with archaeozoological, palaeobotanical and archaeological ones. Numerous elements could be investigated, but many of them are easily subject to diagenetic phenomena (Mg, V, As, Cd, Cu). The most useful elements in this analysis are Barium (Ba), Strontium (Sr) and Zinc (Zn). These three elements are those least affected by diagenetic factors if analysed with an adequate methodology [9-15,7,8]. In this study only two elements were detected Strontium

Citation: Rubini M, Libianchi N, Gozzi A and Zaio P. Patterns of Human Diet in Eastern Sicily (Italy) during the First Millennium BCE. Austin Anthropol. 2020; 4(2): 1018.

and zinc. The barium will be showed in a next study. Sr and Zn are not essential (like the barium) in the metabolic process of the living organism but they are concentrated in animals and plants with high variability depending by the trophic position of the organism [16]. The theoretical basis in the use of these two elements for a try of diet reconstruction is due to the fact that their quantity present in an organism is closely related to the position that it fills in the trophic pyramid. For example the plants that are at the lowest levels in the trophic pyramid absorb Sr directly from colloidal solutions present in the soil. On the other hand the human obtains the strontium and zinc indirectly consuming plants and animals (herbivores, carnivores and fish). Sr and Zn are incorporated in the histochemical structure of the bone tissue as a replacement of Ca in the hydroxyapatites structure [17].

In this study (as mentioned above) only the age range 18-x was used. This choice was effected on the consideration that in sub-adult individuals (infants in particular) there are high proportions of non-crystalline minerals in the bone tissue [17] that supported and predispose it to diagenetic contamination with a high concentration of elements.

Sampling strategies are well known and widely adopted: sampling of soil near and inside the grave, sampling of bone far from areas used for metrical and morphological observations, usually on the femur and tibia, quantification of elements through the atomic absorption spectrometry technique [6,8]. The analysis was undertaken with a latest generation plasma spectrophotometer Perkins-Elmer. The use of the teeth also is possible in this analysis [7] but the main common problem in both sampling is the contamination. It is true that the teeth probably represented the better sampling method because they are made from more resistant material and furthermore they are less porous than bones. But in either cases the control of the contamination is very important and if after an accurate control the result is negative the use is indifferent in both [18].

To analyses the elements were used fragments of the compact bone by the femoral diaphysis [19,8], after submission to histological testing in order to verify the general and structural condition of the bone [20,21]. First, the finds were washed in distilled water and cleaned with a laboratory brush with synthetic bristles. Furthermore, the external 1mm coating of the bones was mechanically removed with a carborundum cutter. After burning in a muffle at 500°C for two hours, the ashes were preserved in a dryer. The next step was to prepare weighing samples of ash (0.5g), later placed in a 50ml pipe of Pyrex glass; for digestion we used a special instrument composed of an aluminium heating unit (TECHNICON BD-40) and a unit for the automatic control of the temperature and time of digestion (TECHNICON BD-20/40). The ashes were treated with 5ml of HNO_3 at 200°C for an hour and a half and later mixed with two 5ml shares each of HNO_3 to heat up to total evaporation. The find showed a white colour. After two hours, it was mixed with HCL 2N; later, heating was used for complete dissolution, and for warming it was brought to volume (50ml).

The elements were determined according to the modality suggested by Szpunar et al., [22]. Only a little modification was introduced for the determination of strontium because the element was determined in the presence of a 5% solution of La $(NO)_3$ and not 1% (as suggested by Szpunar et al., [22]) in order to obtain the complete elimination of the interference of other components of the bone matrix [8]. The elements present in the soil were obtained like general concentration of these. As well known both pH and concentration of the elements in the soil have a great effect on the values obtained in analyses on osteoarchaeological remains [23].

Table 1: Mean values and standard deviation in the human bones and in the soil.

Site	Element	In the bone	In the soil	Evaluation
V.le Ermocrate	Ca (mg/g)	(N=15) 181.2±59.9	124	Not contaminated
	Sr (ppm)	(N=15) 216.6±44.8	192	Not contaminated
	Zn (ppm)	(N=15) 81.4±36.5	11	Not contaminated
Contrada Fusco	Ca (mg/g)	(N=44) 267.2±51.2	212	Not contaminated
	Sr (ppm)	(N=44) 267.2±51.2	178	Not contaminated
	Zn (ppm)	(N=44) 267.2±51.2	53	Not contaminated

Table 1a: Element values in the animals.

Site	Elements	Herbivores	Carnivores
V.le Ermocrate	Ca (mg/g)	197±65.2	201±52.2
	Sr (ppm)	460±80.2	246±63.2
	Zn (ppm)	66±27.3	144±54.6
Contrada Fusco	Ca (mg/g)	272±72.4	212±44.2
	Sr (ppm)	416±65.4	188±29.8
	Zn (ppm)	59±19.3	165±25.8

The results obtained for our samples in the soil contamination control are showed in Table 1.

The Sr and Zn contents are standardised with the Ca values to avoid external contaminants that are not part of the original human bone composition [10,7].

Sr properties are known because of research on Sr 90 dispersion after nuclear experiments. This element has properties similar to those of Ca. It is present in the inorganic bone matrix, taking 99% of Ca's place, and it is very stable even after the individual's death and during burial time [24,12,7]. This element is particularly concentrated in vegetables and vegetal products, so that it is present mostly in herbivores and in good concentration in fish.

Sr values in human bone could be considered a good indicator of indirect assumption of vegetables, cereals and fish during the life. The other element employed in this study was the zinc, mostly present in meat (especially in red meat), milk and dairy products, in crustaceans and some molluscs and in some food of vegetal origin, such as nuts and beans (those that are rich in plantula proteins) [25,19,13,26,8].

To standardise their concentration, we must also know whether animals (herbivores and carnivores) that lived in the same site at the same time and relate the two ratios (correction with the site). Their values were showed in table 1a.

This method also allows us to compare our data with those obtained for groups living in different areas and in different times [10,11].

Furthermore, during the deposition of bone in the soil significant changes in Ca/P ratio can occur as a consequence of the secondary

Table 2: Comparison between male and female individuals of V.le Ermocrate and Contrada Fusco.

Site	Element	Males (7 individuals)	t-test of Student M vs F	Females (8 individuals)
V.le Ermocrate	Sr/Ca correction site	0.85±0.77	t=0.27; p=0.79	0.76±0.51
	Zn/Ca	0.37±0.25	t=-1.43; p=0.17	0.51±0.11
Contr. Fusco		Males (7 individuals)		Females (8 individuals)
	Sr/Ca correction site	0.59±0.30	t=-1.41; p=0.16	0.75±0.45
	Zn/Ca	0.45±0.17	t=0.91; p=0.36	0.41±0.10

Table 3: Mean values and standard deviations of Sr/Ca and Zn/Ca for every class of age of Contrada Fusco males and females.

Contrada Fusco	18-30 years	31-45 years	More than 45 years
M: Sr/Ca	N°=11; 0.57±0.26	N°=9; 0.66±0.34	N°=5; 0.53±0.32
M: Zn/Ca	N°=11; 0.43±0.13	N°=9; 0.52±0.23	N°=5; 0.39±0.09
F: Sr/Ca	N°=6; 0.65±0.38	N°=8; 0.82±0.60	N°=5; 0.75±0.29
F: Zn/Ca	N°=6; 0.34±0.13	N°=8; 0.46±0.09	N°=5; 0.43±0.04
M+F: Sr/Ca	N°=17; 0.60±0.30	N°=17; 0.73±0.48	N°=10; 0.64±0.34
M+F: Zn/Ca	N°=17; 0.40±0.14	N°=17; 0.49±0.18	N°=10; 0.41±0.06

increase of these macro-elements fundamental in the bone-building [17]. An important condition in the study of osteoarchaeological remains is that the phisiological value of the Ca/P was maintained [27]. In fresh human bones the range of Ca/P ratio assumes values between 1.8 and 2.19 [28]. In the first sample the Ca/P ratio show a value of 1.97 for the females and 2.12 for the males, while the mean for sexes combined is 1.99. In the second sample the values are 2.09 for the females and 1.95 for the males, while the mean for sexes combined is 2.04.

For the statistical analysis was used the t-test method suggested by Cavalli Sforza [29] for biological samples:

$$t=\frac{m_a - m_b}{S}\sqrt{\frac{n_a . n_b}{n_a + n_b}}$$

Where m_a and m_b are the means of the two subsamples, s the mean of the standard deviations and n_a and n_b the number of observations.

Results and Comments

The values of pH in the external soil and in the grave are neutral (pH = 6.-6.7). The values obtained in the quality control of the samples (contamination) were showed in the (Table 1). In both samples, the concentration of the elements in the soil appears to be less than in the bone, so we could therefore exclude their diagenetic contamination. Furthermore, the control also of the physiological values of the Ca/P ratio confirms the quality of the samples (Table 1a).

Comparison between genders. The results obtained are showed in Table 2. A higher intake of Sr compared to the Zn is present in the individuals of Viale Ermocrate (8^{th}-6^{th} century BC). This result could indicate a nutrition strictly connected with a diet based on vegetables and cereals, although we cannot exclude the presence of fish in consideration of the proximity of the site to a river and overall to the sea. The assumption of proteic food could be desultory and/or connected with particular or important events [30]. Probably the milk and dairy products were the main food rich in proteins eaten with a regularity. It is interesting to note that the females have a higher value of Zn in contrast to the males, even if it is not statistically significant (Table 2). On the other hand, the Sr values are greater in the males than females. Normally we should expect the opposite result, because in ancient society, the best food was assigned to the males and the meat was considered an important and eminent aliment in proto-historic and historic society (2000). In this sample, the diet of the two genders seems to be different in concentration also (as mentioned above) if it is not statistically significant (Table 2). Probably the access to the alimentary source was diversified only for proteic aliments.

With regard to the Contrada Fusco individuals (3^{rd} Century BC), we can observe a new pattern of the concentration ratio between Sr and Zn in the males (Table 2).

The increase of Zn in the male sample could indicate a change of alimentary habits probably because of a new situation linked to the cultural and economic flow coming from the Southern Italy. During the 3^{rd} century BCE the increase of the Roman power in the Mediterranean basin could have also influenced alimentary choice. The creation of a real market in foodstuffs permitted a better choice of food producing new effects in the diet. The "palatability" became diversified because the food supply was diversified, and everyone could choose his favorite food according to his wealth and economic possibility. This phenomenon probably reduced sexual discrimination in the choice of food, a status symbol in ancient prehistoric and proto-historic communities [30]. The diet of males only seems changed (not statistically) in contrast with older sample.

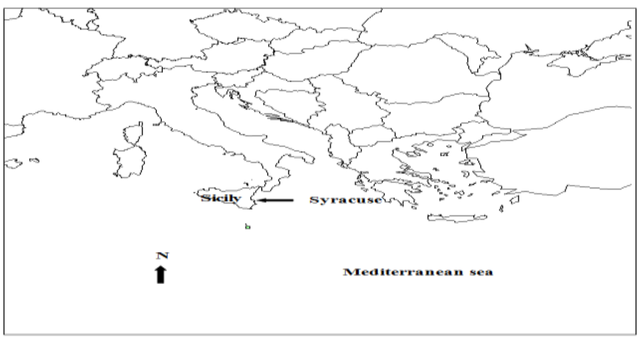

Figure 1: Sicily location in the Mediterranean Basin.

Figure 2: Location sites in Syracuse.

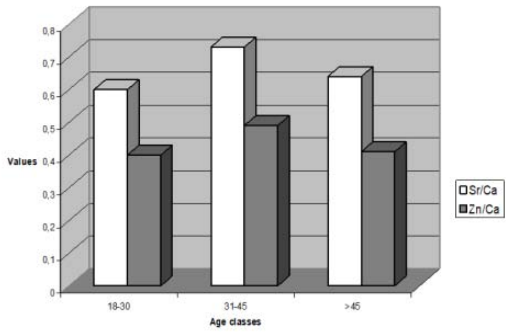

Figure 3a: Trend values of Sr/Ca in the Hellenistic Syracuse population (M+F).

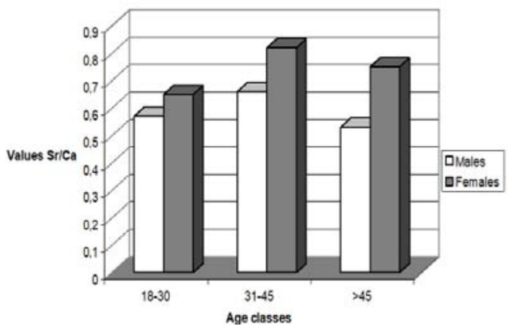

Figure 3b: Comparison values Sr/Ca between gender and age classes in Syracuse of 3rd century BC.

The decrease of Sr contents is compensated by the increase of the Zn value. The male diet appeared well balanced in concentration of the elements in comparison with the females even if poorer in quantity.

Comparison between age groups. This comparison was possible only for the Hellenistic sample because of the scarce N of the older sample. The sample of Contrada Fusco was subdivided into three classes by age and sex: (a) 18-30 years, (b) 31-45 years, (c) more than 45 years (Table 3 and Figure 3a,b&c). This population shows the maximum values of the elements in the age class 31-45 (Table 3 and Figure 3a), followed by the third age range (>45) and the first (18-30). These results indicate a greater concentration of elements during one of the life period most active under working aspects.

Females show greater values of the Sr in all range (Table 3 and

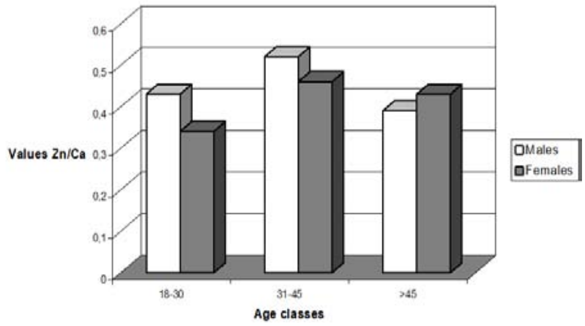

Figure 3c: Comparison values Zr/Ca between gender and age classes in Syracuse of 3rd century BC.

Figure 3b); while the males in the first and second range show greater values of Zn (Table 3 and Figure 3c). It was interesting to note the female value of Zn in the class >45. The result seem suggest an easiest access to proteic food for the oldest women. This fact could be due also to a different quality of food and represent only a diversification of quality and not quantity. Nothing of the t-test comparisons was significant (Table 3).

The male diet seems poorer in concentration of elements, in comparison with female sex, but perhaps well balanced. With regard to this observation it was applied, in both genders, a test of correlation between Zn and Sr values: “r” coefficient [29]. The result of “r” shows a value of 1 for the males. It indicates a correlation statistically significant between Zn and Sr contents and indirectly in the assumption of protein and carbohydrates during the adult life. This could sustain our hypothesis of a balanced diet. In the females the “r” value was 0.984, which is absolutely not significant. To summarize, the male diet seems show a poor diet but with greater choice of aliments, while the female diet seems more occasional.

Comparison between cemeteries. (Table 4) displays that there is no clear difference between the nutritional patterns in Viale Ermocrate and Contrada Fusco. The only significant difference was recorded in the Zn/Ca ratio between females: the former shows a higher concentration of Zn/Ca intake than the latter. These data could indicate a real change in the alimentary habits of the female relative to the reduction of proteic aliments.

This phenomenon can not be interpreted easily, the cause could be different: dietary habits in different historical periods or simply chance.

To conclude, we can observe that our two population samples show a similar diet with cereal and vegetable intakes higher than animal protein ones, which appear in any case to be slightly lower than standard ones.

These data agree with literary sources on the economy of this area [31-33] which describes a subsistence based on cereals (barley and wheat), pulses (vetch, lupines, broad beans) and fruit (pears, pomegranates, figs). In addition they also could suggest a discrete consumption of fish, considering its high value for Sr, this could better explain our results for this element. Proteins intake was represented mostly by pork, both fresh and salted, as cattle were employed in agriculture and goat and sheep in milk and wool production [32,33].

Table 4: Comparisons between mean values of Sr/Ca and Zn/Ca with t-test for the sites of Viale Ermocrate and Contrada Fusco.

Element	Viale Ermocrate	t-test	Contrada Fusco
Sr/Ca M+F	N°=15; 0.80±0.64	t=1.023; p=0.311	N°=44; 0.66±0.38
Zn/Ca M+F	N°=15; 0.44±0.19	t=0.21; p=0.82	N°=44; 0.43±0.14
Sr/Ca M	N°=7; 0.85±0.77	t=1.39; p=0.17	N°=25; 0.59±0.30
Zn/Ca M	N°=7; 0.37±0.25	t=0.99; p=0.32	N°=25; 0.45±0.17
Sr/Ca F	N°=8; 0.76±0.51	t=0.05; p=0.96	N°=19; 0.75±0.45
Zn/Ca F	N°=8; 0.51±0.11	**t=2.30**; 0.05<p<0.001**	N°=19; 0.41±0.10

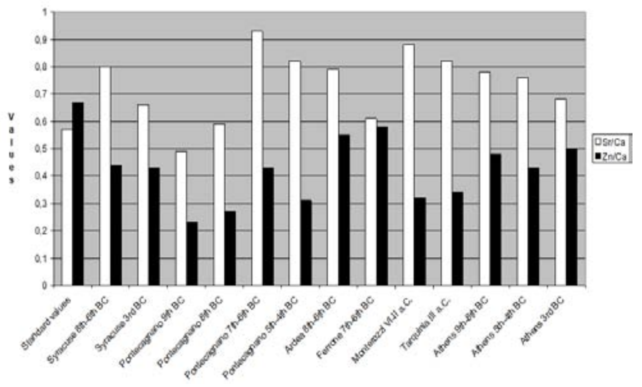

Figure 4: Comparison among population of the Mediterranean Basin in the 1th millennium BC.

The historical studies also testify to a large consumption of walnuts, pistacchio nuts and chestnuts, which contain zinc, even if in lesser quantity than red meat [33].

Comparison among populations of the Mediterranean Basin. To understand the alimentary model practised during the 1st millennium BCE in the Mediterranean, our samples were compared with others from the Greek and Italian area (Figure 4). The ratio between elements shows greater values of Sr in comparison with Zn in all cases. The high values of Sr in the Mediterranean diet could suggest a great production of cereals and vegetables leading to hypothesize an

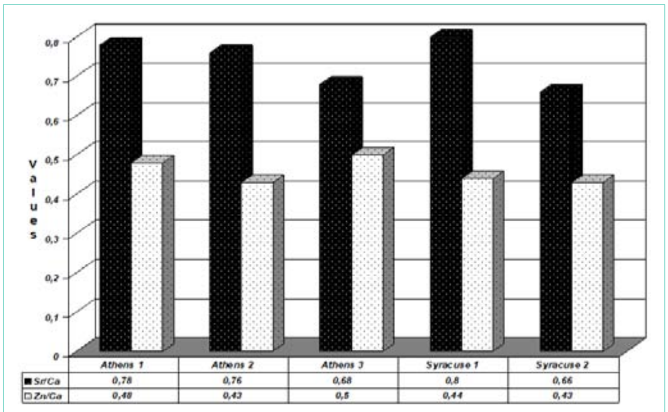

Figure 5: Comparison among Athens and Syracuse sites M+F.

economic pattern prevalently based on agricultural practice during the 1st millennium BCE. Fish and crustaceans probably constituted a complement to the diet for coastal sites. The importance of sheep breeding and rearing seems proportional to the Zn content and presents a great variability not only chronologically but among sites. This result could be connected to the wealth of the site in a certain period or most simply to the change in "palatability". It is interesting to note that the Syracuse and Athens sites show a similar trend (Table 5 and Figure 5).

The Sr value decreases over time in all samples; only the Zn rises in the Hellenistic population of Athens. The graphic homogeneity was confirmed by the application of t-test, which shows not significance in all comparisons except between Zn contents in the Hellenistic samples of Athens and Syracuse (Table 6). Furthermore, there is a significant change of diet in the females between 9th-8th and 3rd century among the Greeks, like at Syracuse, but in this case, it concerns only the Sr content (Table 4&6).

Greek society was based on a subsistence economy of agricultural model [10,33]. This pattern was connected to the nature of the territory and probably also to the climate [34,35].

Our results show that the Greek colonisers of Syracuse practised

Table 5: Element values in Athens and Syracuse Samples.

Elements	Syracuse 1	Syracuse2	Athens 1	Athens 2	Athens 3
Sr/Ca M+F	N=15; 0.80±0.64	N=44; 0.66±0.38	N=15; 0.78±0.18	N=6; 0.76±0.18	N=17; 0.68±0.23
Zn/Ca M+F	N=15; 0.44±0.19	N=44; 0.43±0.14	N=15; 0.48±0.08	N=6; 0.43±0.05	N=17; 0.50±0.12
Sr/Ca M	N=7; 0.85±0.77	N=25; 0.59±0.30	N=7; 0.55±0.12		N=5; 0.86±0.51
Zn/Ca M	N=7; 0.37±0.25	N=25; 0.45±0.17	N=7; 0.51±0.12		N=5; 0.58±0.23
Sr/Ca F	N=8; 0.76±0.51	N=19; 0.75±0.45	N=8; 0.98±0.24		N=12; 0.61±0.11
Zn/Ca F	N=8; 0.51±0.11	N=19; 0.41±0.10	N=8; 0.45±0.06		N=12; 0.47±0.08

Syracuse 1 (S1) = 8th-7th BC; Syracuse 2 (S2) = 3rd BC; Athens 1 (A1) = 9th-8th BC; Athens 2 (A2) = 6th-5th BC; Athens 3 (A3) = 3rd BC.

Table 6: T-test comparison between Syracuse and Athens sites and between genders and chronology in Athens samples.

	S1*vs*A1	S1*vs*A2	S1*vs*A3	S2*vs*A1	S2*vs*A2	S2*vs*A3	A1*vs*A3 F	A1*vs*A3 M	A1*vs*A3 M+F
Element	"t"	"t"	"t"	"t"	"t"	"t"	"t"	"t"	"t"
Sr	0.12	0.15	0.72	1.17	0.63	0.2	**4.7****	1.59	0.73
Zn	0.74	0.12	1.08	1.29	0	**1.82***	0.06	0.63	0.31

M = Males; F = Females; * = P<0.05; ** = 0.05<p<0.001. Syracuse 1 (S1) = 8th-7th BCE; Syracuse 2 (S2) = 3rd BCE; Athens 1 (A1) = 9th-8th BCE; Athens 2 (A2) = 6th-5th BCE; Athens 3 (A3) = 3rd BCE.

this economy also in Sicily, where the climate and territory are very similar to their homeland.

Conclusions

The diet in eastern Sicily was based on aliments of carbohydratic origin complemented with a sufficient intake of proteins. The two Syracusan sites seem prefer an agricultural production (or importation) of cereals and vegetables in comparison to the cattle breeding. Probably also a discrete fishing activity was present in both periods. During the 8th-7th century, BCE the possibility of access to the alimentary sources probably was the same in both genders. The same diet model was present also in Athens [10], although the Greek colonists of Syracuse were from Corinth according to the historical sources. The diet of the peninsular Greeks in various sites seems to be rather homogeneous [10], especially on those close to the sea. Certainly, the fish intake was limited to coastal sites because of the difficulty in keeping it fresh. Marine crustaceans, on the other hand, could have been transported to inland sites, given their greater resistance out of water.

Coastal peninsular Greece and Sicily both show very similar characteristics of climate and territory. In reason of the comparative results obtained the Greek colonists show that they had not difficult in establishing their productive tradition on the coasts of eastern Sicily. Here they produced the basic foodstuffs of their diet.

In the 3rd century BCE in Syracuse the diet do not seems to have undergone variations in its make-up with respect to the previous period analyzed. The only variation was the parameter of the quantity in concentration of the elements, a probable sign of an impoverishment in dietary assumptions. The Zn content in the female sex decreases significantly, even in statistical terms. This phenomenon could indirectly show a general productive impoverishment that could have influenced the female sex more greatly. Hellenistic Athens also shows the same symptom, limited however to the Sr concentration. In the future ulterior analysis could be helpful to understand better this particular and interesting aspect of the ancient population of the Mediterranean basin.

Acknowledgement

I would like to thank Beatrice Basile of the Archaeological Superintendence of Syracuse, Archer Martin, Archaeology Supervisor of the American Academy in Rome for consultation in the translation and Vittorio Cerroni and Fiorello Testa for their kind help.

References

1. Rubini M, Bonafede E, Mogliazza S. The population of the East Sicily during the second and the first millennium B.C. The problem of the Greek colonies. International Journal of Osteoarchaeology. 1999; 9; 8-17.
2. Holloway RR. The Archaeology of the ancient Sicily. Routledge. New York. 2000.
3. Rubini M, Mogliazza S. Il popolamento dell'Italia dal Neolitico ad oggi. Italian Ministry of Culture. Rome. 2006.
4. Buikstra JE, Ubelaker DH. Standards for Data Collection from Human Skeletal Remains. Arkansas, Archaeological Survey Research Series No. 1994; 44.
5. Sandford MK. A reconsideration of trace element analysis in prehistoric bone. Skeletal Biology of Past Peoples: research method. 1992; 79-103.
6. Bartoli F, Lippi B, Carnieri E, Usai L, Mallegni F, Bertoldi F. New paleonutritional data from Mediterranean prehistoric populations: an attempt at interpretation of the changes in diet and economy through time. XIVe Congres de l'Union Internationale des Sciences Prehistoriques et Protohistoriques, Liège. 2002. 2-8.
7. Szostek K, Glab H, Pudlo A. The use of strontium and barium analyses for the reconstruction of the diet of the early medieval coastal population of Gdansk (Poland): A preliminary study. Journal of Comparative Human Biology. 2009; 60: 359-372.
8. Gallello G. Western Mediterranean Archaeology: Chemical Element Levels in Archaeological Materials as a Methodological Tool. PhD thesis. Valencia University. 2014.
9. Lambert JB, Szpunar CB, Buikstra JE. Chemical analysis of excavated human bone from Middle and Late Woodland sites. Archaeometry. 1979; 21: 115-129.
10. Bisel SC. A pilot study in aspects of human nutrition in the ancient eastern Mediterranean, with particular attention to trace mineral in several populations from different period. PhD University of Minnesota. Minneapolis. 1980.
11. Schoeninger MJ. Diet and evolution of modern human form in the Middle East. American Journal of Physical Anthropology. 1982; 58: 37-52.
12. Sillen A, Smith P. Weaning patterns are reflected in Strontium-Calcium rations of juvenile skeletons. Journal of Archaeological Science. 1984; 11: 237-245.
13. Klepinger LL. Nutritional assessment from bone. Annual Review of Anthropology. 1984; 13: 73-96.
14. Gilbert RJ. Stress, palaeonutrition and trace elements. Gilbert RJ, Mielke JH, editors. In: The analysis of prehistoric diets. New York. 1985; 339-358.
15. Burton JH,Wright LE. Non linearity in the relationship between bone Sr/Ca and diet: palaeodietary implication. American Journal of Physical Anthropology. 1995; 96; 273-282.
16. Price TD, Johnson CM, Ezzo JA, Ericson J, Burton JH. Residential mobility in the prehistoric southwest United States: a preliminary study using strontium analysis. J. Archaeol. Sci. 1994; 21: 315-330.
17. Silvestroni C. Elementi di chimica inorganica. UTET. Turin. 2013.
18. Rubini M, Cerroni V, Zaio P. L'attività del servizio di Antropologia della S.B.A.L. nell'area predestina. Lazio e Sabina. 2014; 10: 44-47.
19. Lambert JB, Simpson SV, Buikstra JE, Hanson D. Electron Microprobe analysis of elemental distribution in excavated human femurs. American Journal of Physical Anthropology. 1983; 59: 131-140.
20. Grupe G, Garland AN. Histology of Ancient Human Bone: Methods and Diagnosis-Springer-Verlag-Berlino. 1993.
21. Ceccanti B, Landi A, Bartoli F, Mallegni F, Masciandaro G, Carmignani A. Study and control of the geochemical processes responsible of diagenetic alteration of archaeological bones. Second International Conference on Soil and Archaeology, Pisa. 12th-15th. 2003.
22. Szpunar CB, Lambert JB, Buikstra JE. Analysis of excavated bone by atomic absorption. American Journal of Physical Anthropology. 1978; 48: 199-202.
23. Sandford MK, Weaver DS. Trace element research in anthropology: new perspectives and challenges. Katzenberg MA, Saunders SR, editors. In: Biological Anthropology of the Human Skeleton. Willey-Liss, New York. 2000; 329-350.
24. Sillen A, Kavanaugh M. Strontium and palaeodietary research: a review. Yearbook of Physical Anthropology. 1982; 25: 67-90.
25. Blakely RL, Beck LA. Trace elements, nutritional status and social stratification at Etowah Georgia. Annals of the New York Academy of Science. 1981; 376: 417-431.
26. Gilbert RJ. Stress, palaeonutrition and trace elements. Gilbert RJ, Mielke JH, editors. In: The analysis of prehistoric diets. New York. 1985; 339-358.
27. Giblin J. Strontium isotope and trace element analysis of copper age human skeletal material from the Great Hungarian Plain. Unpublished Undergraduate Honor's Thesis. The Florida State University, College of Arts and Sciences,

Tallahassee. 2004; 1-39.

28. Sanchez-Quevedo MC, Ceballos-Salobrena G, Rodrıguez IA, Garcıa JM, Campos A. Quantitative X-ray microanalytical and histochemical patterns of calcium and phosphorus in enamel in human amelogenesis imperfecta. Int J Dev Biol. 2001; 45: 115-117.

29. Cavalli Sforza L. Statistica per medici e biologi. 9th edition. Boringhieri Milano. 2009.

30. Grottanelli V. Principi di Etnologia. UTET. Torino. 2001.

31. Fornaciari G. Indagini palenutrizionali su campioni di popolazioni antiche del bacino mediterraneo. Atti del convegno “Uomo e Agricoltura”, seminario di Scienze Antropologiche. Suppl. 1982; 1: 65-73.

32. Fidanza F, Liguori G. Nutrizione umana. Idelson. Napoli. 1988.

33. Fidanza F. L’alimentazione nel bacino mediterraneo, ed. Laterza. Bari. 1999.

34. Gilbert C, Sealy J, Sillen A. An investigation of barium, calcium and strontium as palaeodietary indicators in the southwestern Cape, South Africa. Journal of Archaeological Science. 1994; 21: 173-184.

35. Rubini M. Alimentation and social roles in the past. Armelagos G, Goodman A, Rubini M, Coppa A, Corruccini RS, editors. In: “1st Summer School in Paleoanthropology” SAL Tivoli. 2000.