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Arheological and archaeozoological evidence of milk as a food in the territory of Croatia

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Summary

According to the recent data the cattle domestication and use of milk as a food was older then considered before. Cattle domestication started 8,000 years B.C. that was proven from the various bones debris, whereas milk use was confirmed on the bases of fatty acid analyses on the pottery fragments as early as 5,000 years B.C. Early centres of cattle domestication were located at the Eastern Mediterranean area, and in the North Africa from where the cattle were spreading also to today's Croatian area. In Copper and Bronze Age Europe new pottery forms appear that have been associated with dairying. Chemical analysis of late Eneolithic Baden culture pottery showed that some pottery types were used for production or storage of milk and its products. Based on the faunal data from the Eneolithic Vučedol archaeological site, numbers of bones, teeth and horn fragments were identified, with the significant domination of the female population throughout all cultural layers. It is believed they were most probably used for the reproduction and the milk production. Direct proofs for milk consumption by the local prehistoric population, based on the fatty acid determination from the pottery fragments were not evident. It can only be assumed that lactose tolerance was developed similarly to central and northern European populations. Simultaneously with genetic research, mentioned analyses and results will be valuable contribution for better understanding in development of metabolic and degenerative disease in modern humans, developed under the influence of the changes in dietary habits and environmental factors during the evolutionary interval.

Key words: milk, food, archaeozoology, fatty acids, arguments, health

Introduction

Milk is considered as one of the oldest foods in the world. Ruminant milk has been used for nourishment for millennia because it contains most of the nutrients necessary for a quality diet. It is rich in substances of various chemical compositions which participate very effectively in certain physiological functions support, and is therefore considered to be a complete food that can considerably vary in composition depending on species, animal feeding and keeping (Marenjak et al., 2006; Marenjak et al., 2009). Throughout history, certain civilizations, and individuals belonging to certain societies, developed the ability to use and digest unfermented milk effectively in an adult age, thereby gaining a considerable advantage in survival and subsisting. This refers primarily to the ability to digest lactose that could be recognized through LP allele prevalence (Burger et al., 2007). Was it lactose tolerance that brought the development of dairy farming or did frequent contact with milk lead to the development of lactose tolerance? Recent research sheds light on this issue, but the first European settlers were certainly lactose intolerant (Burger et al., 2007). Historical evidence for using cattle to produce secondary foods such as milk on archaeological excavation sites is mostly

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based on various debris of bones and pots that were probably used in the milk production. Based on an available historical evidence and archaeological findings milk was intensively used as a food as early as the 5th millennium B.C., although the domestication of cattle, sheep and goats started as early as 8,000 years BC (Sherratt, 1983). It is presumed that there were two possible early centres of cattle domestication: the Eastern Mediterranean and North Africa. The evidence for domestication in the Eastern Mediterranean derives from Çatal Hüyük. The cattle from layer VI (5,800 B.C.) were smaller than wild cattle and they corresponded in size to domesticated cattle from later sites in Anatolia (Perkins, 1968). Domesticated cattle were also identified on the Agrissa Magoula site in Thessaly (Greece) which dates to the 7th millennium B.C. Those cattle are contemporary, or even older, than the cattle at Çatal Hüyük.

It is possible that a great centre of domestication developed in the north eastern Mediterranean basin and neighbouring areas (including Thessaly and Macedonia) around 6,500 BC (Bökönyi, 1973). The evidence for domestication in North Africa comes from excavations in Nabta and Bir Kiseiba in the Egyptian Western Desert (Crabtree, 1993) and dates between 6,800 and 7,500 B.C. Archaeozoological evidence for cattle domestication found in the Croatian area, such as the Vučedol archaeological site located 4.5 km southeast from Vukovar, on the right bank of the Danube. Forenbaher (1995) estimated that the Vučedol settlement could have been comprised of 285 households with a total of 1,000-1,500 inhabitants. There are three distinct Eneolithic (Chalcolithic) layers found in this area: the Baden culture (3,400-3,150 B.C.), the Kostolac culture (3,250-3,000 B.C.) and the Vučedol culture (3,000-2,400 B.C.). All three cultures are very similar, with almost identical fire places and cylindrical pit construction methods, ceramics production, and all share the same farming mentality (Durman, 1988), but the precise evidence on milk usage and preparation of dairy products are still under the investigation. Therefore, the objective of this article is to present historical facts, corroborated by scientific evidence, about the milk consumption and use in prehistoric Croatia, and to emphasize the possibility of applying certain methods, such as extracting trace of fat from dishes, in attempts to get direct and reliable evidence about usage of milk and/or dairy products as a food in certain cultures of prehistoric Croatia.

Archaeozoological evidence of milk production

It is believed that there are substantial differences in bone samples from animals used strictly for meat production, and those used for secondary purposes such as milk production. Identification is possible by allocation based on sex and age differences (Rackham, 1994). However, in the literature, there are some queries against such conclusions mainly because the excavated samples do not contain bones of all animals that could have inhabited the area (Bartosiewicz, 1998). When someone is performing archaeozoological analysis, it is important not to ignore the fact that part of the material from the past times was never recovered, that the most of the material was irreversibly destroyed over time and that some of the animals that once lived was never buried (Kužir and Trbojević Vukičević, 2004).

The archaeozoological evidences for secondary production exploitation in nearby area of Central Balkan region (i.e. the eastern part of former Yugoslavia) was provided by Greenfield (Greenfield, 1988a, 1988b). He collected faunal samples from 13 Late Neolithic (4,500-3,300 B.C.) and Post Neolithic (3,300-1,000 B.C.) sites and tested the hypothesis that secondary product exploitation of domestic animals first become a major feature of European subsistence strategies in the Post Neolithic (Bökönyi, 1974; Sherratt, 1983). Together with mentioned investigation, the later researches and tests on archaeozoological data from the same periods in Central Balkan, indicates that during Late Neolithic domestic cattle production appears to have been oriented toward meat production (Greenfield, 1991). During Post - Neolithic there are significant changes based on long-term stability and mixed animal exploitation, with an emphasis on secondary products (Greenfield, 2005). As a conclusion of those investigations, milking has its origins in the Neolithic of the Near East and spreads to Europe (Greenfield, 2010).

In Vučedol, most of the findings date to the Baden culture layer, especially the classic and late Baden period (3,300-3,150 B.C.). Osteological analysis confirmed 41 % taxonomic identification, noting that it was especially difficult to distinguish

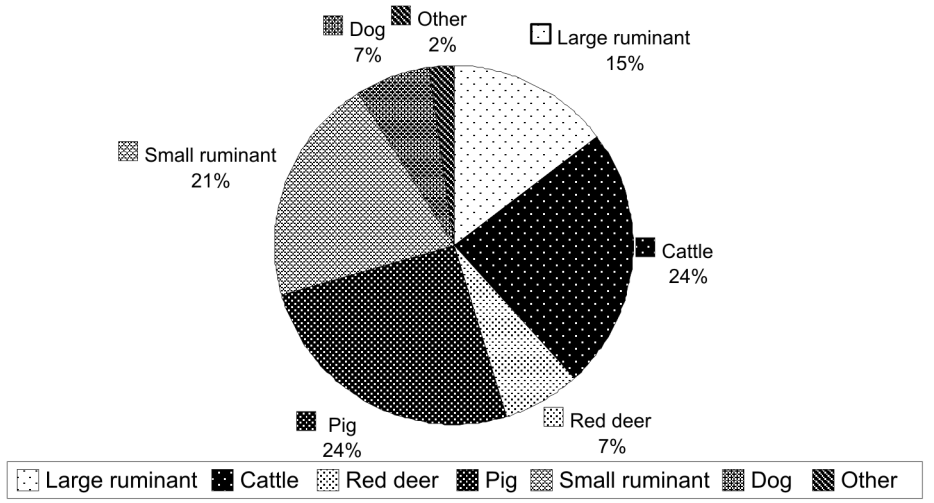

Figure 1. Distribution of bone and teeth findings, according to taxonomical groups, from Vučedol archaeological site, Baden culture (Kužir, 2002)

wild from domesticated animals of the same species (Kužir, 2002; Figure 1). Since some of the elements were determined with certainty to be bones of large ruminants (domesticated and wild cattle, red deer), cattle (domesticated and wild cattle), small ruminants (sheep, goat and roe deer), and pigs, many bone elements needed a more thorough, competent analysis. Considering the fact that a relatively significant portion of the findings consists of large ruminant remains, among which cattle bones are present, a prevailing number (40 %) of cattle bone remains can be confirmed for the Baden culture of the Vučedol site (Kužir, 2002). It is difficult to prove the use of animals for secondary purposes by archaeozoological analysis, especially when applied on individual bones. On the bones of domesticated cattle, on which it was possible to carry out a sex determination (mostly metapodials, but also another long bones on which osteometrical analysis can be done), a significant female domination was noted in all cultural horizons (Trbojević Vukičević, 2006). A relatively small portion of male animals suggests that the Eneolithic population had a distinctly livestock-oriented mentality: A large number of middle aged (3 and 5 years) females were present, probably for the purpose of reproductive maintenance of the herd, but most probably for the milk production.

New approach in methodology of identification of cattle utilization for milk production in prehistory

There is no direct evidence regarding a timeline or an extent of milk usage amongst the population of prehistoric Croatia. Numerous sites testify a considerable diet diversity, cattle keeping, and eventually meat and milk processing.

Archaeological site Vučedol and numerous prehistoric sites in east Slavonia are of great interest for testing the secondary production revolution, because they are situated near Greenfield's (1988a) Central Balkans area. Those regions were at the land routes of movement for people, animals, goods and information between Near East and Central Europe, so if secondary product exploitation was introduced into Central Europe from the Near East, it would have had to pass through Croatian region - Slavonia. One of the possible methods that could demonstrate milk use as a secondary product is identification of milk residues on ceramics. In Copper and Bronze Age Europe new pottery forms appear that have been associated with dairying (Craig, 2002). So called milk jug (potbellied or biconical jug with two handles under the rim) is leading ceramic type of the middle Eneolithic Bodrogkeresztúr culture (Bognár-Kutzian, 1963). It had an important role in mortuary practices and can be found at middle Eneolithic necropolises (Šavel et al., 2009). Al-

though the term "milk jug" indicates use of milk and secondary products, it has to be considered that the term was introduced in 1927 (Hildebrand, 1927) based on ethnographic analogies. To verify if this pottery type really had a connection with milk and dairy products, residues analysis on several different pottery types from middle and late Eneolithic period in Hungaria were performed. The analyses were based on determination of protein residues. From the middle Eneolithic period, eight milk jugs were analysed and only one of them had milk protein traces. The results did not prove enhanced milk products portion within middle Eneolithic period and put a question for term "milk jug" for mentioned pottery type (Craig et al., 2003). However, the fatty acid analyses were not performed that seemed more useful in the case of contamination with other organic debris (Copley et al., 2003). A relatively broad spectrum of Baden pottery types, instruct that in the late Eneolithic period dairy products had a larger role in human nutrition. Milk residues were traced in biconical bowls with everted neck and flutting on the inside of the rim, jug and large storage recipients (Craig et al., 2003; Horváth and Simon, 2003). Biconical bowls (Fig. 2) are characteristic of Baden culture. They are present at almost every site attributed to this late Eneolithic culture (Dimitrijević, 1979; Horváth and Simon, 2003).

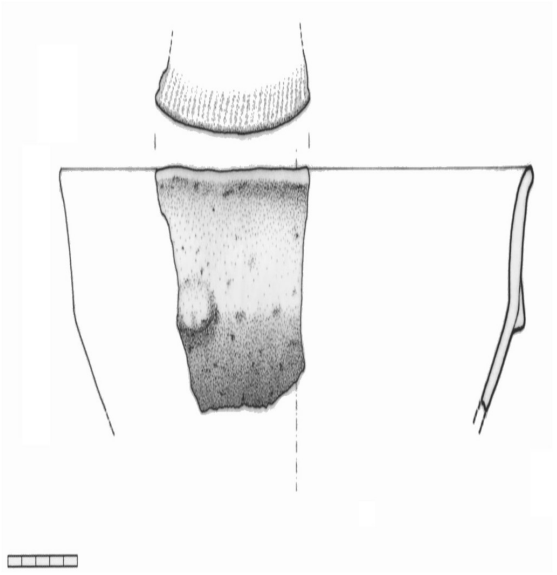

Figure 2. Fragment of biconic bowl with everted neck and flutting on the inside of the rim from Josipovac Punitovački - Veliko polje I, Croatia (Čataj, 2009, T.4.1)

There is some genetic evidence that fresh milk drinking started 7,500 years ago between the Central Europe and Central Balkans from where it spread across the Europe (Yuval et al., 2009). All evidence of milk as a food in the diet of the Neolithic population in the territory of Croatia is based on archaeozoological bone findings, and on authentic colanders and sieves, and other dishes used for keeping dairy products, but there is no biochemical evidence so far.

According to Copley et al. (2003) absorbed organic remains, especially fatty acids from the dishes, provides fairly accurate historical evidence of cattle or small ruminants breeding for the milk production and consumption that had been supporting the economic status of certain societies and cultures. Hence, fatty acids from prehistoric remains can serve as direct evidence for the use of lipids of animal origin. In explanation, ceramic dishes are highly porous and, if used to store or boil milk, intensively absorb organic matter. Fresh milk contains a high amount of short-chain fatty acids ($C_{4:0}$-$C_{12:0}$) but they disintegrate over time because short-chain fatty acids are mostly found on the *sn*-3 position in triacylglycerols. They are sensitive to hydrolysis and are more water-soluble than long-chain fatty acids. Consequently, the remnants of dairy fat and fatty acids found on ceramic debris from archaeological sites are mainly determined based on long-chain fatty acids, primarily stearic acid. It is therefore important to discern dairy fat remnants from body fat remnants which is possible via the stearic ($C_{18:0}$) and palmitic ($C_{16:0}$) acid content ratio (Figure 3).

According to Copley et al. (2003) carbon from carbohydrate food is used more often for biosynthesis of body fat than dairy fat, that is, stearic acid from dairy fat develops 40 % by biohydrogenation from unsaturated fatty acids, oleic, linoleic, and linolenic acid. Based on the lipid extraction protocol and fatty acid extraction and analysis described in details in Evershed et al. (2002) report, an extensive use of milk was determined for the early Neolithic period in the south part of the British Peninsula (Copley et al., 2005).

By using the same biochemical method, Evershed et al. (2008) proved that cattle, sheep and

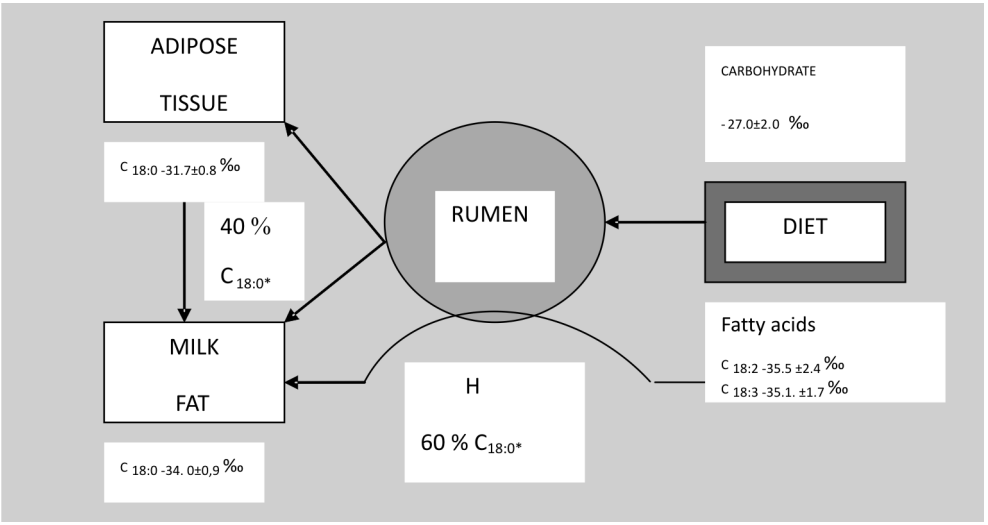

Figure 3. Rumen, adipose tissue and milk gland fatty acids and carbohydrate metabolism in ruminants (according to Copley et al., 2003)

*60 % of milk fat stearic acid originate directly from the diet after the biohydrogenation processes of linoleic and linolenic fatty acids in the rumen of ruminants

goats were used for different purposes in the northwest Anatolia region, according to the bone remnants findings. The milk was used as a nutritious food at other investigated sites to a lesser extent versus a greater prevalence of goat, sheep and pig meat for consumption purposes. How can the farming for meat production be distinguished from farming for the purpose of secondary production? It could be distinguished by using the prehistoric finds and applying several chemical criteria, primarily by determination of dairy fat remnants, particularly by composition of saturated fatty acids, the double bonds position and distribution in triacylglycerol. Also, it is possible to determine the age of ancient fat origin using a radioactive carbon isotope. In addition, the data is supplemented by bone fragment findings because it is presumed that there are significant differences between bone samples from animals used exclusively for meat production and animals used for secondary products production. Most of the bone samples from animals bred for meat production contain a larger share of remains of animals age 1-2 years, and adult, mostly female animals which were used for breeding, whereas bone samples from animals bred for secondary product production contain a larger number of bones from animals under 6 months, and of females that dominated in adult population (Rackham, 1994). At Vučedol site (Trbojević Vukičević, 2006), depending on evaluation method, the numbers of juvenile cattle are less present (between 10.52 and 14.05 %), the sub adults are slightly numerous (between 14.04 and 15.78 %) and adults are the most numerous with 71.81-73.67 % range.

Implication of milk production on the population health

Identification of the first cattle farmers and their possibilities to breed the animals for the milk production, significantly change the perception of dietary habits and their influence on health and economic conditions in a society. According to Sherratt (1983) and Levy (1983), the secondary products revolution was considered to have started in the 5th or 4th millennium B.C. On the contrary of Burger et al. (2007) conclusions, recent investigation of group of scientist supposed lactase persistence 7,500 years ago across the Linearbandkeramic culture (Yuval et al., 2009). Surely, the biological advantage of lactose tolerance (LT) individuals lies in a possible constant availability of a highly nutritious food, rich in calcium, especially in periods of inferior wheat harvests (Burger et al., 2007). Therefore, the use of dairy products, such as yoghurt or cheese (in which lactose is mainly broken down to lactic acid), provided

the possibility for using milk as a highly valuable food in the diet of the prehistoric population. Based on archaeological findings in north-western Anatolia, a substantial understanding of milk production was confirmed. Establishment of the fatty acid analyses method in dishes remnants and computer simulation method according the genetic and archaeozoological findings will contribute in further investigation of the prehistoric Croatian population period that would give better knowledge of milk use as food, or/and trading product on the territory of Croatia.

Conclusion

Numerous prehistoric sites in east Slavonia are of great interest for testing the secondary production revolution, because they are situated near Central Balkans area, which is at the land routes of movement for people, animals, goods and information between Near East and Central Europe. Taking into account the current archaezoological findings and authentic colanders, sieves and other dishes used for keeping dairy products, there are indirect evidence of the use of milk and/or dairy products on Croatian territory. The determination of biochemical markers on archaeological remains would provide a more thorough knowledge of the use of milk as food for nutrition and exchange for other products.

Arheološki i arheozoološki dokazi o mlijeku kao namirnici na području Hrvatske

Sažetak

Prema novijim podacima udomaćivanje goveda, kao i upotreba mlijeka kao namirnice, starije je nego što se smatralo. Domestikacija goveda započela je 8000 g. pr. Kr., a izravni dokazi o mogućem korištenju mlijeka postoje na temelju ostataka životinjskih kostiju i na temelju ostataka mliječne masti, prvenstveno masnih kiselina na posuđu, prema kojima se mlijeko koristilo već unazad 5000 g. pr. Kr. Centri rane domestikacije goveda rasprostirali su se na području istočnog Mediterana i sjeverne Afrike i otuda su se goveda proširila i u naše krajeve. U razdoblju eneolitika i brončanog doba u Europi se javljaju novi keramički oblici koji se dovode u vezu s mljekarstvom. Kemijske analize keramike kasnoeneolitičke badenske kulture pokazale su na nekoliko tipova posuđa da su korišteni za proizvodnju ili čuvanje mlijeka i mliječnih proizvoda. Na temelju podataka o fauni eneolitika vučedolskog arheološkog nalazišta utvrđen je veći broj fragmenata kostiju, zuba i rogova goveda, sa značajnom dominacijom ženki u svim kulturnim horizontima. Smatra se da su najvjerojatnije korištena u rasplodu i za proizvodnju mlijeka. Direktnih dokaza o upotrebi mlijeka na temelju utvrđivanja ostataka masnih kiselina u posuđu nema, no možemo pretpostaviti da se tolerancija na laktozu razvila kao i na području centralne i sjeverne Europe. Istovremeno s genetskim istraživanjima navedene analize i rezultati mogli bi imati primjenu u svrhu boljeg poznavanja razvoja metaboličkih i degenerativnih bolesti vezanih uz prehrambene navike današnjeg stanovništva.

Ključne riječi: mlijeko, namirnica, arheozoologija, masne kiseline, dokazi, zdravlje

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