A Case Study of Human Adult Lactose Absorption in Mongolia

KIYOSI TAKAHASI¹ AND DUBJIR SUVD²

1 *Department of Anthropology, Faculty of Science, The University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113, Japan*

2 *Institute of Biotechnology, Academy of Sciences Mongolia*

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Abstract Human adult lactose absorption in Mongolia is investigated. Each test subject was determined to be a lactose absorber or a malabsorber by the use of a field version of the lactose tolerance test with breath hydrogen determination. The phenotypic frequency of adult lactose absorber in Mongolians was shown to be relatively low compared to other milk using populations in Europe, Arabia and Africa. The frequency was also compared with those of two Chinese populations, Han and Inner Mongolians, where no statistically significant difference was found.

Key Words: adult lactose absorption, milk utilization, gene-culture coevolution.

INTRODUCTION

Some human populations are exceptional among mammals with respect to their relatively high phenotypic frequencies of adult lactose absorbers. Biochemical backgrounds of individuals with different phenotypes, lactose absorbers and malabsorbers, have been examined. Boll *et al.* (1991) have shown that individuals with different phenotypes can code for identical lactase. This and other studies (e.g., Witte *et al.*, 1990) suggest that differences in posttranscriptional regulation of lactase synthesis may be responsible for the phenotypic polymorphism due to allelic variation at an autosomal regulatory locus (Potter *et al.*, 1985; Sebastio *et al.*, 1989).

Some theoretical models have been proposed to account for the high frequencies of adult lactose absorbers in some populations. For example, Simoons (1970), McCracken (1971) and Kretchmer (1972) proposed adaptive coevolution of a mutant gene and the cultural phenotype of milk utilization in their “culture historical hypothesis.” Several field studies have been carried out to estimate the phenotypic frequencies of adult lactose absorbers mainly in populations with dairy cultures, giving theories some numerical data. The frequencies among Kazakh and Inner Mongolians, two Chinese populations with dairy cultures, together with that of Han have been determined by Wang *et al.* (1984). Since no information about lactose absorption in Mongolia has been obtained, we attempted the study in Mongolia.

MATERIALS AND METHODS

The lactose absorption test was held in Ulaanbaatar, the capital of Mongolia, on 20 healthy adults (15 females and 5 males) whose ages ranged from 20 to 52 years, with an average age of 32.8 years. Among the subjects 16 are from Khalkha, 2 from Buryat, and 2 from Bait (Bayad).

The test was performed following the procedures of a field version of the lactose tolerance test with breath hydrogen determination (Howell *et al.*, 1981). Test subjects ingested lactose monohydrate (50g/300ml water) after at least 8 hours of fasting. Breath samples were collected immediately before, and 120 and 150 minutes after lactose ingestion, by inflating 8 liter balloons with two to three deep expirations. Samples were stored in 350ml aerosol cans using a hand operating pump. The hydrogen concentrations in these samples were determined by gas chromatography (Howell *et al.*, 1980). The maximal difference in breath hydrogen concentration between one of two samples collected 120 and 150 minutes after lactose ingestion and the sample obtained before lactose ingestion was calculated, being the diagnostic parameter, $\Delta_{\max} \text{H}_2$. The subjects who exhibited a substantial increase in H_2 concentration ($>20\text{ppm}$) in their expiratory air after ingestion were identified as lactose malabsorbers, whereas $\Delta_{\max} \text{H}_2$ is below 15ppm in lactose absorbers. Symptoms of lactose intolerance were recorded 150 minutes after the lactose ingestion.

RESULTS

Fig. 1 shows the distribution of $\Delta_{\max} \text{H}_2$ values in the samples of 20 subjects. According to the criteria described in the methods, one subject with $\Delta_{\max} \text{H}_2$ value of -3.0ppm was determined to be a lactose absorber, while 19 subjects with $\Delta_{\max} \text{H}_2$ values between 21.9 and 111.5ppm were classified as lactose malabsorbers.

Among 19 malabsorbers, 4 reported no symptoms, though 3 of them felt a little nausea. Seven felt flatulence (abdominal gas formation) and eight were reported to have suffered from diarrhoea accompanied by flatulence. The absorber exhibited no symptoms.

In Table 1, the frequency in Mongolians is compared with those of Han and Inner Mongolians. No statistically significant difference was found between the frequency in Mongolians and those of other two. Among the malabsorbers, we could not find any association between $\Delta_{\max} \text{H}_2$ values and the severity of the symptoms.

Fig. 1. Distribution of $\Delta_{\max} H_2$ values of 20 subjects.

Table 1. Distribution of lactose absorbers and lactose malabsorbers in two Mongolian populations and Han. In the parentheses are the fractions in percent. Inner Mongolians refers to the Mongolian people now living in the People’s Republic of China. Data of Inner Mongolians and Han are cited from Wang *et al.* (1984).

Population	Number of subjects	Lactose absorbers	Lactose malabsorbers
Han	248	19 (7.7%)	229 (92.3%)
Inner Mongolians	198	24 (12.1%)	174 (87.9%)
Mongolians	20	1 (5.0%)	19 (95.0%)
Total	466	44 (9.4%)	422 (90.6%)

Han: Mongolians $\chi^2 = 0.20, 0.6 < P < 0.7$. Inner Mongolians: Mongolians $\chi^2 = 0.91, 0.3 < P < 0.4$.

DISCUSSION

It is believed that Inner Mongolians have mixed with Han, who are traditionally farmers (Batsuur and Dashnyam, personal communication), which might have resulted in genetic divergences of Inner Mongolians from Mongolians. The relatively low phenotypic frequency of adult lactose absorbers in Inner Mongolians, compared to European, Arabian and African populations with frequencies higher than 0.5 (e.g., Kretchmer *et al.*, 1971; Sahi *et al.*, 1973; Bayoumi *et al.*, 1982; Flatz *et al.*, 1982; Hijazi *et al.*, 1983; Flatz *et al.*, 1986), may be due to this admixture with the farming population. According to this view, Mongolians, with less admixture with Han, should show higher phenotypic frequency of adult lactose absorbers, comparable to those of European, Arabian and African populations. This cannot be supported from our present study.

Another explanation may be obtained when we consider the Mongolian way of milk utilization (Nozawa, 1991). Mongolian nomads consume a lot of horse milk as their food resources. The horse milk is known to contain more lactose (6.2 to 6.7%) compared to cow milk (4.6%). Relatively high concentration of lactose causes horse milk to be easily fermented. Fermentation changes lactose into lactic acid and reduces the lactose concentration so that malabsorbers can drink horse milk without experiencing discomfort. Fermented horse milk is one of the main dishes, rather than just a drink, for Mongolian nomads and loved by everyone including juveniles, being the only liquor in Mongolia juveniles are allowed to drink.

With a very low degree of vegetable intake, nomads may sometimes suffer from serious constipation caused by the deficiency of food fiber. Mongolian nomads, in such cases, suffer intentionally from diarrhoea by taking a large quantity of lactose by drinking non-fermented horse milk. It is thought to be very healthy to drink non-fermented horse milk once in a while and is practiced also among many of city residents.

It may be possible that their way of milk utilization, reducing lactose by fermentation, is the cause of the relatively low phenotypic frequency of adult lactose absorbers in Mongolians, for reduction of lactose may also reduce the adaptive differences between lactose absorbers and malabsorbers.

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