BONE CHINA OF LAPLAND IN FINLAND

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INTRODUCTION

The investigation of bone china from Lapland in Finland is evaluating the possible to utilize wastes of reindeer bone as a raw material for a clay body. In the district of Sodankylä in Lapland there are two slaughter-houses, which produce reindeer bone wastes. In Finland the Arabia porcelain factory has manufactured bone china late in the 19th century, and the production has restarted recently. In England there is a long and well known tradition of bone china design and the industrial treatment of bone ash.

OBJECT

The object is to develop bone china from reindeer bone wastes in the Sodankylä region in Lapland. The firing temperatures and milling quality is investigated for the reindeer bone in order to obtain a raw material to be used mixing clay body. The amount of other Finnish raw materials mixed in bone china is also investigated.

Fig. 1. The material process of reindeer bone china

MATERIALRESEARCH

Calcining, milling and pH of the reindeer bone ash

Reindeer bone ash was manufactured as a raw material from unselected bone parts. Crushed slaughter residues were calcined at different temperatures both in gas and electrical furnaces. The heated bone ware without any carbon after the firing. At temperature of 1170 °C the bone was sintered and at 800 °C the bone was porous. The calcination temperature influences the crushing and milling time of the bone. The burned bones ware crushed and filtered to a grain size of 0.125 mesh. The ash powder was water grinded in ball mill between 80 and 140 hours. The grain size of two samples of bone ash was measured, the particle size were > 10 microns and < 8 microns. An imported bone ash had particle size < 25 microns. The mineral composition of general bone ash includes calcium phosphate 85.9 %, calcium carbonate 5.9 %, magnesium phosphate 3.80 % and sodium and potassium chloride, 5.15 %. The effect of milling times changes pH value in bone ash when water or dry grinded. In preliminary experiments pH value was 9. The pH value is in the normal casting slip between 5 and 6. The high pH increases the flocculation of the bone china casting slip, and weakens the casting properties.

Fig. 2. Water grinded reindeer bone ash

The casting and firing of reindeer bone china.

For mixing clay body it was selected other Finnish raw materials such as orthoclase (feldspar FFF) and quartz (FFQ), from England china clay (ECC Standard porcelain). The mineral composition of feldspar FFF (SP Minerals Ltd., 1998) is 44 % orthoclase, 45 % albite, 4 % anorthite and 7 % quartz Finnish quartz FFQ is of high quality containing 98 % SiO_2. The ratio of the raw materials was selected in order to obtain a

softening effect of feldspar FFF on the reindeer bone ash. The bone china casting time is between 2-3 minutes and the mixture is highly thixotropy. Water silica was replaced by the flocculant Dolapix PC 67 (Zschimmer &Schwartz). Another important additive is Optapix 1C 1000 G. The opacity increased when the bone china clay body M1 was fired slowly. The firing program was 1. stage, 100 C/h to 300 °C, 2. stage 100 C/h to 900 °C and 3. stage 60 C/h to 1230 °C. The glaze firing was 1100 °C and soaking time 10 minutes.

RESULTS

The analyses of clay bodies M1 and M2 with Reindeer bone ash and Feldspar FFF, have been calculated and compared with original bone china by English Cornish Stone (CS) (Table 1). The opacity and crystallization of the calcium phosphate clay body is based on the eutectic melting ability of the Cornish Stone or Feldspar FFF in this case.

Table 1: Chemical analyses of Reindeer Bone China M1 and M2 compared with Japanese Bone China.

Reindeer Bone China M1 FFF* (CS **) wt%		Reindeer Bone China M2	Japanese Bone China ***
SiO_2	45.68 (46.52)	32.96 (34.45)	34.9
Al_2O_3	12.37 (12.09)	15.00 (14.52)	15.8
Fe_2O_3	0.19 (0.19)	0.24 (0.24)	0.4
TiO_2	-	0.05 (0.08)	0.1
CaO	21.40 (21.57)	25.98 (26.29)	26.6
K_2O	1.65 (1.09)	2.68 (1.68)	1.8
Na_2O	0.73 (0.51)	1.32 (0.92)	0.4
P_2O_5	17.98 (17.96)	21.76 (21.75)	19.8

*) Finnish Flotation Feldspar**) Cornish Stone, England***) Japanese Bone China Company 1998

The bone china M1 is softening and is more opaque than the clay body M2 at lower temperature. The high amount of aluminium oxide in the clay body M2 effects the crystallization and opacity. The samples were all tested up to 1300 °C. The aim was as low sintering point as possible in bone china when used reindeer bone ash. The bone china M1 and M2 has stable shrinkage and absorption during firing range 1200-1250 °C

Table 2: Results of firing Reindeer Bone China M1 and M2.

Reindeer Bone China M1, gradient 1300 °C				Reindeer Bone China M2, gradient 1300 °C			
Temp.°C	Trans.	Shrinkage[1)]	Absorption[2)]	Temp.°C	Trans.	Shrinkage[1)]	Absorption[2))]
1300	****	15.0	0.03	1300	****	13.6	0.07
1275	****	12.1	0.04	1275	****	12.8	0.09
1250	****	12.0	0.38	1250	****	12.1	0.19
1225	****	12.8	0.40	1225	***	12.0	0.62
1200	***	12.0	0.89	1200	**	12.1	0.80
1175	**	11.7	nd.	1175	**	11.4	1.43
1150	*	nd.	nd.	1150	*	nd.	nd.
1125	-	nd.	nd.	1125	-	nd.	nd.

1) ASTM C326-82(1992)
2) ASTM C373-88(1994)

The clay body manufactured from reindeer bone ash is aesthetic of high quality; white and opaque. In this respect the use of reindeer bone for bone ash as a raw material can replace common used cattle bone. It is compatible with opacity and low firing values of traditional bone china.

Fig.3. The reindeer bone china has high quality of whiteness; like snow in Lapland.

CONCLUSIONS

The slaughter residue from Lapland in Finland can be used for the preparation of raw material for ceramics. The reindeer bone ash changes the values of the material based design production more material design aesthetic, where the Nordic culture is emphasized. The reindeer bone china has high quality of whiteness; it is like snow in Lapland.

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Fig.4. Opaque Reindeer bone ash baked in the glass material