Natural Colours for Terracotta Jewellery

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Abstract- In this paper experiment for development of terra sigillata for terracotta jewellery in different shades of brown, orange, white and grey is presented using clay found in and around Wardha. The terra sigillata thus developed has been used in terracotta jewellery. The technology was successfully implemented by the self help groups and has been effectively commercialised under brand of Wardhani and Kalpak.

Index Terms- terracotta jewellery, terra sigillata, clay, natural colour

I. INTRODUCTION

Terra sigillata is a very smooth, lustrous coating of clay which resembles a glaze and is virtually waterproof. The name means "sealed earth" and has been used to refer to the Classical Greek Attic figures painted in black and red on pottery (Fourts, R., & Belgium, B., 2004). It can be made from any kind of clay, which is found locally and mixed as a thin liquid slip. When it settles down, fine particles are separated out to be used as terra sigillata.

To achieve a glow ranging from a smooth silky lustre to a high gloss, terra sigillata is polished with a soft cloth or brush on the surface of green (unbaked) ware. The primary objective of terra sigillata slip coatings is to get a high satin gloss without a glaze, using simple, time-effective polishing methods. Polishing refers to the process that produces a shine on the clay surface. The particles in the slip decoration are so fine that they partially fuse together during baking; this partial fusion is called sintering. These bodies are smooth and shiny similar to a glaze surface and are also water-proof (Cizer, S 1999).

Indian artisans have developed technologies which are easily available, adaptable, utilitarian and cost effective. In a review of indigenous practices it was found that even today potters are using locally available fine clay to colour their pottery. The pottery artisans are preparing slips based on finest bright clay available in natural deposits in their own locality and by using water from pond or rain.

Potential of Terra Sigillata around Wardha

When different regions, of (periphery of 200 Kilometers) Wardha district were reviewed it was found that the colour of clay was different in each region. Hence the possibility, that a combination of clay from different regions may give a complete colour shade card suitable for jewellery. With the help of local potters from Wardha, a chain was established between the potters of Nagpur, Chandrapur, Gadchiroli, Amravati & Balaghat regions. Fine clay which was locally available and the traditional process for the preparation of terra sigillata/clay colour were collected from different areas, which is as follows-

Vidarbha is the eastern region of Maharashtra. It is made up of Nagpur and Amravati Division. It borders the state of Madhya Pradesh to the north, Chhattisgarh to the east, Andhra Pradesh to the south and the area of Marathwada and Khandesh of Maharashtra to the west. Geographically Vidarbha lies to the north of Deccan Plateau. Unlike the Western Ghats, there is no major hill in this area. The Satpura Range lies to the north of Vidarbha in Madhya Pradesh. Large basaltic rock formation is found throughout Vidarbha, caused by the Deccan lava trap. Wainganga is the largest river in Vidarbha. Other major rivers that drain region of Vidarbha are the Wardha, and Kanhan which are the tributaries of Godavari. Samples no 1 to 6 collected from different region of Vidarbha.

Figure 1, Map of Maharashtra State, India

Madhya Pradesh in Hindi can be translated as Central Province, and is located in the geographical heart of India. The state straddles the Narmada River, which runs east and west between the Vindhya and Satpura ranges; these ranges and the Narmada separates North India from the South. The state of M P bordess to the west by Gujarat, to the northwest by Rajasthan, to the northeast by Uttar Pradesh, to the east by Chhattisgarh, and to the south by Maharashtra. The Satpuras (Pansemal), in the Gawilgarh and Mahadeo Hills, also contain a lake, which is to the south, rivers like Indrawati, the Wainganga, the Wardha, the Pench, the Kanhan and Penganga, discharge an enormous volume of water into the Godavari. The Godavari is the lifeline of Andhra Pradesh, but the water which feeds it, is a gift of the Central India watershed. Samples 7 and 8 were collected from district Balaghat, Madhya Pradesh.

Figure 2, Map of Madhya Pradesh State, India

Rajasthan's main geographic features are the Thar Desert and the Aravalli Ranges, which runs through the state from southwest to northeast, almost from one end of state to the other, for more than 850 km. Mount Abu lies to the south-western end of the range, separated from the main range by the West Banas River. The area of Hadoti lies to the southeast, bordering Madhya Pradesh. To the north of Hadoti and Mewar lies the Dhundar region, which is home to the state capital of Jaipur. Dausa is the District of Rajasthan which is about 80 kms from Jaipur. The city of Dausa is the district headquarter. The red soil used for terra sigillata (sample number – 9) was collected from the richest pottery cluster of Dausa Rajasthan, to compare with locally available clay used as a terra sigillata.

Figure 3 Map of Rajasthan State, India

II. DESCRIPTION OF SAMPLES COLLECTED

Total nine samples were collected from three different states. Sample wise details are explained in following paragraphs-

1) **Sample no 1** – (Hills near Wardha, district Wardha, Maharashtra) – Wardha is located between 20°45'N 78°36'E and 20°75'N 78°60'E. It has an average elevation of 234 meters. A hill in Wardha is called Hanuman takeri. Soft rocks are found in between the big rocks. Fine black colour particles are obtained on grinding these rocks. The surface of particles produced a shade of brown (RGB 107; 73; 48), when baked.

Figure 4, Site of fine soil, Wardha

Figure 5, Soil sample collected from Wardha

Figure 6, Terra sigillata made with soil sample of Wardha and applied on terracotta beads

2) **Sample no 2– (**Village Pawni, Taluka Ramtek, district Nagpur, Maharashtra) -The district of Nagpur is located between 21°09′ N, and 79°09′ E. Pawni is about 50 kilometres from Nagpur. The clay site is about 15 kilometers from Pawni and situated in the forest of Hivrakheda. Some hundred years ago the potters of this village saw wild animals licking clay with their tongues. Three layers of clay are available here, but the wild animals licked only the black layer which was in the middle in the middle. They brought samples of the clay from middle layer and prepared from this, a few terracotta articles. The surface of articles thus produced had a very smooth finishing with bright brown shade (RGB 93; 64; 42). They then decided to use this clay to give smooth finishing to the terracotta articles.

Figure 7, Map of Nagpur district

Figure 8, Site of fine clay, Pawni

Figure 9, Clay sample collected from Pawni

Figure 10, Terra sigillata made with fine clay of Pawni and applied on terracotta beads

3) **Sample no 3–** (Village Khothurna, Taluka Parshivani, district Nagpur, Maharashtra.)- The village Khothurna is about 25 kilometer from village Pawni. The traditional Red murram soil (coarse red soil) site is situated in the forest, which is about 5 kilometer from the village Khothurna. The colour of this murram soil is deep red. Potter's use this murram soil along with the fine clay of Pawni. When murram soil was mixed with the fine clay of Pawni, the resulting colour was brown after baking (RGB 111; 67; 38) and it is very close to semi sweet chocolate (RGB: 107; 66; 38).

Figure 11, Site of murram soil, Khothurna

Figure 12, Sample of red murram soil collected from Khothurna

Figure 13, Terra sigillata made with soil of Khothurna and applied on terracotta beads

4) **Sample no 4 –** (Village Zadi, district Gadchiroli, Maharashtra) - District of Gadchiroli is situated in the south-eastern corner of Maharashtra. Gadchiroli is located between 20°06′N 80°99′E and 20°10′N 80°0′E. It has an average elevation of 217 meters. The main river basin of the district is the Godavari, which flows from west to east and forms the southern boundary of the district. The major tributaries of the Godavari are the Indravati and the Pranhita, which in turn are formed by the confluence of the Wainganga and the Wardha near Chaprala village of Chamorshi Taluka. Mr Sankar Kapat a trader from Nagpur collects the fine clay from Zadi village of Gadchiroli district and sells it to the local potters of Nagpur, Bhandara, Wardha, etc. These potters are using this fine clay to give a natural glaze to their terracotta articles. Orange colour was obtained after baking (RGB: 148; 77; 57) which is a shadelighter than Salmon 4.

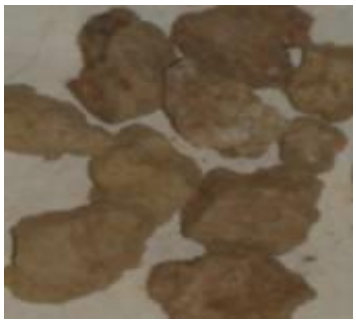

Figure 14, Sample of clay collected from Zadi.

Figure 15, Terra sigillata made with clay collected from Zadi and applied on terracotta beads

5) Sample no 5– (Village Rajura, district Chandrapur, Maharashtra.)- Rajura is a city and a municipal council in the district of Chandrapur, Maharashtra. It lies in the heart of the coal and cement producing areas of Maharashtra. Rajura is located between 19°47′N 79°22′E and 19°78′ N 79°37′E. It has an average elevation of 181 meters (593 feet). Rajura is located on the banks of River Wardha. Clay was collected from murum bolder mines near the village Virgaon, which is about 10 kilometres from Rajura. There is a layer of white clay, below the murram bolder. This white clay was used to make terra sigillata which gives white shade (RGB: 193; 168; 159).

Figure 16, Sample of clay collected from Rajura

Figure 17, Terra sigillata made with clay collected from Rajur and applied on Terracotta Beads.

6) Sample no 6 – (Village Bhankhed, district Amravati, Maharashtra) – The district is situated between 20°32' N 76°37' E and 21°46' N 78°27' E. Puma, the largest river of the district, arises from the southern slopes of Gawilgarh hills and flows through Amravati taluka. Fine red clay sample was collected from the hill which is situated in between the village Bhankhed and Chandur in Amravati. The potters of Bhankhed are mixing this clay collected from the hill with clay from paddy field for a better performance during preparation of pottery wares. Clay paint was made with this red clay and after baking it gave shade of orange (RGB 134; 74; 52) which is slightly deeper than Salmon4.

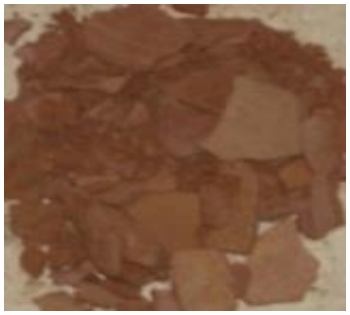

Figure 18, Sample of clay collected from Bhankhed.

Figure 19, Terra sigillata made with clay of Bhankhed and applied on terracotta Beads

7) Sample no 7 – (Village Khairlanji, district Balaghat, Madhya Pradesh.) - Balaghat district is located in the southern part of Jabalpur division. It occupies the south eastern portion of the Satpura range and the upper valley of the Wainganga river. The district extends from 21°19' to 22°24' north latitude and 79°31' to 81°3' east longitude. The Wainganga and its tributaries are the most important rivers in the district. The town of Balaghat is on the Wainganga, which flows to the north and south

through the district. The village of Khairlanji, is situated in between Nagpur and Balaghat. It is about 139 kilometers from Nagpur and 46 kilometers from Balaghat which is the district headquarter of Madhya Pradesh. The site of this fine clay is about 3 kilometers from Khairlanji and near to Wainganga river. After baking the colour of this clay becomes orange (RGB: 104; 46; 33).

Figure 20, Site of fine clay, Khairlanji.

Figure 21, Sample of clay collected from Khairlanji.

Figure 22, Terra sigillata made with clay of Khairlanji and applied on terracotta beads.

8) Sample no 8- (Village Khamaria, Taluka Katangi, district Balaghat, Madhya Pradesh.)- Katangi is a town and a nagar panchayat in Balaghat district. Katangi is located at 21°47' N 79°47' E and 21°78' N 79°78' E. It has an average elevation of 442 meters (1450 feet). The village of Khamaria is about 60 kilometres from Khairlanji. Fine clay is available here in the fields and this spot is nearly 5 kilometres from village Khamaria. The potters collected the bright black clay from agricultural fields and after baking it turned in shade of deep brown (RGB: 116; 84; 56).

Figure 23, Site of fine clay, Khamaria.

Figure 24, Soil sample collected from Khamaria.

Figure 26, Terra sigillata made with clay of Khamaria and applied on terracotta beads.

9) Sample no 9- (Village Baswa, district Dausa, Rajasthan) – Soil was collected from the potters of village Baswa, which is in mandal Bandikui, district Dausa, Rajasthan. The district of Baswa is about 11 kilometres from its mandal main town Bandikui. Baswa is 38.5 kilometres far from the city of Dausa. The district is situated in between 26°23' to 27°15' North Latitude and 76°07' to 77°02' East Longitude. Also, the mean sea level height of the district is 333 meters. The Sawa and Ban Ganga rivers run through the district. The potters collect the soil from the nearby hills. Generally this type of red coarse soil is found in-between the big rocks. Potters dig the soil during rainy season when the soil is loose and is easy to collect from the rocks. After baking it gives deep orange colour (RGB: 99; 41; 33).

Figure 26, Soil sample collected from Baswa.

Figure 27, Terra sigillat made with soil of Baswa and applied on terracotta beads

III. STANDARD INDIGENOUS PROCESS TO PREPARE TERRA SIGILLATA

There are many ways to prepare natural colour of clay. Simple local method of the region for the preparation of colour was adopted for experimenting. The process is as follows-

1.Fine clay was mixed with rain water in an earthen pot. Clay particles develop a negative charge when mixed with water and become separate from each other. During this process, positively charged particles float down on the surface of the water while the negatively charged clay particles settle at the bottom of the pot. If the settling is too rapid, it does not allow coarse particles to become separated from the finer ones. It is necessary for the antique slip that the particles are fine enough to be suspended in water. Therefore, the water must not contain positively charged alkaline earth oxides (BeO, MgO, SrO, CaO, BaO) so that the clay particles are not surrounded by positively charged particle deposits (Cizer, S 1999).The proportion is usually one part clay to two parts of water and if the plasticity of clay is more, than the proportion will go up to 1:4.

2. Clay and water were mixed thoroughly in order to break down all lumps coarse particles settle down at the bottom of pots. These were removed and the clay was mixed with hand thoroughly along with water for about 15 minutes every day.

3. After third day the mixture was left undisturbed for about 24 hours. It settled down into two or three clear layers. The top most layer of the solution looks turbid.

4. The thin top most solution is carefully siphoned into another pot. After four or five days, maximum amount of water evaporates from the top. Now a paste of a very fine mixture of clay and water remains at the bottom of the pots. Some mixtures were very thin and percentage of water in it was more due to the percentage of clay, the clay sample must be less in quantity or seepage of water from the bottom of pots may be less. The thin mixture was then heated on gas stove in order to become thick. The mixture was heated up for sometime on low heat stirring continuously all the time with the help of a spoon. If the mixture is not stirred then the terra sigillata at the bottom of the pot will become a solid lump.

5. This thick mixture contains very fine particles of clay, which is called **Terra Sigillata** and it can be used as paint on un-baked and dry-bone clay wares. Application of two or three layers of terra sigillata gives a perfect shine and glaze.

6. This mixture cannot be stored, as it becomes dry quickly. This mixture has to be immersed in water for 24 hours. In this process the particles or terra sigillata gets mixed with water and then it is painted on the surface of beads. (Vince Pitelka, 2007).

7. The first phase is to study the basic colour of terra sigillata which is prepared from a type of clay. Then during the second and third round different types of clays were mixed in equal proportion in order to achieve different shades of colour.

8. The beads were baked in a small up-draft kiln which is designed specially for terracotta beads, maximum temperature necessary for baking process was 750 degree centigrade.

9. For the standardization of terra sigillata combination of different types of clays, colour values of different clay beads and pendants were fixed in accordance with RGB standards with the help of Colours Picker. It is very difficult to maintain the exact shade of colour of beads because colour of beads and pendants is not uniform. Picture of beads and pendants was enlarged and a spot with uniform shade was selected to fix the colour value.

IV. RESULTS

Broadly speaking different shades of colour like brown, orange, gray and white was obtained with the use of clay mentioned above. The following results were obtained during experiment-

Shades of Brown Colours - The different shade of brown colour was achieved with the use of clay from Wardha, Pawni, in Maharashtra and Khamaria in Madhya Pradesh. The colour of clay from Pawni gives smooth silky lustre to a high gloss. The RGB values are in between 93; 64; 42 to 116; 84; 56 (Table-1).

Shades of Orange Colours -. Different shades of orange colour were achieved with the use of clay from the village Baswa, district Dausa, Rajasthan; village Khairlanji, District Balaghat, Madhya Pradesh, village Bhankhed, Dist Amravati, village Zadi, District Gadchiroli, Maharashtra; (Table-1). The colour of soil from Dausa (RGB 99; 41; 33) is very deep as compared to the colours of Khairlanji (RGB 109**;** 43; 30), Bhankhed (RGB 134; 74; 52) and Zadi (RGB 148; 77; 57). The colour of clay from Bhankhed is quite similar to Salmon-4 (RGB 139, 76, 57).

Shade of White Colour – The colour of terra sigillata achieved from fine clay of Rajur (RGB:193;168;159) is deeper than wheat3 RGB 205;186;150 which is part of white colour shade (Table-1). The terra sigillata of Rajur can be used to prepare tints of different shades.

Mixing of Different Shades of Clay- Different shades of brown colour were obtained by mixing different shades of orange with brown. The colour obtained from the mixture of clay form Pawni and Zadi (RBG 82, 38, 27) is close to Black Brown (RGB 83,37, 16) and clay of Pawni & Khairlanji (RGB 94,43,22) is similar to Beiga Brown (RGB 94, 56, 22). The colour obtained by the mixture of clay from Pawni and Khothurna (RGB 111, 67, 38) is similar to semi sweet chocolate (RGB 107, 66, 38). The mixture of clays from Pawni, Rajura and Wardha (RGB 137, 94, 67) is similar to dark wood (RGB 133, 94, 66) and mixture of Pawni and Rajura (RGB 157, 106, 71) is very close to dark tan (RGB 151, 105, 79). Mixing of two or three type of clay gives an extensive range of brown colour shades with RBG values 82, 38, 27 to 157, 106, 71 (Table-2). Clay from Rajura **(**RGB 193, 168, 159) is used in different ratio to prepare tints (Table-3) of Khairlanji (RGB 109, 43, 30) which is near to Beige Brown DK (RGB 109, 66, 39)) (Kevin J. Walsh, 2007).

Usually clay contains calcium carbonate and iron oxide or these can be added. Iron oxide gives the article a fine red colour after baking. Calcium carbonate causes the colour of the article to turn yellow and increases mass expansion so that it adapts along with the thermal expansion of the decoration.

Modification of Process to obtain Black & Grey Colour- To obtain natural grey colour, different experiments were conducted with the locally available indigenous technical know-how. After applying the terra sigillata on the surface of the green-beads, the horn of goat and saw dust was kept inside the closed pots containing beads of clay. On baking at 750 degree centigrade, the beads in both the pots become grey.

This grey colour obtained from saw dust (RGB 21, 21, 21) is very smooth and glossy and it is above the grey -8 (RGB 20, 20, 20). The grey colour obtained with horn (RGB 11, 11, 11) is above the grey-4 (RGB 10, 10, 10) along with this, deposits were observed on the groves of black beads (Table-1).

Terracotta jewellery- Due to non-availability of pottery clay in the region of Wardha it was mutually decided by District Rural Development Agency, Wardha &Mahatma Gandhi Institute for Rural Industrialization (MGIRI), Wardha, to introduce terracotta product which required minimum amount of clay and to get maximum return in terms of profit. The requirement of clay in the production of terracotta jewellery is very less and after proper finishing it will be sold at a good price.

In order to give natural colour to terracotta jewellery, monochromatic colour scheme, analogous colour scheme and complementary colour schemes are found suitable. A monochromatic colour scheme is a scheme which is based on only one colour. This works well specially with a piece of jewellery of light and dark shade with different surface finishing and of different shapes and sizes. Mono-chromatic colour schemes are derived from a single base colour and further extended by using its shades, tones and tints (that is, a colour modified by the addition of black, grey and white). As a result, the appearance is more subtle and harmonious due to a lack of colour contrast.

The palette has the dark, medium and light values of a single colour. Though it does not have any depth, it provides the contrast of dark, medium and light shade, which is important to achieve a good design.

A range of terracotta with natural coloure was designed with monochromatic colour scheme at MGIRI Wardha. Hence the Self Help Groups are commercially producing naturally coloured terracotta jewellery (Figure -28 & 29).

V. CONCLUSION

Composing the terracotta jewellery with shades of brown orange, white and grey gives very conspicuous and natural look. This also increases the commercial value of indigenous technical knowledge of artisans. Mixing of different types of clay gives variation in the shade, which is a positive output for jewellery designing.

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Figure 28, Newly designed terracotta jewellery in two colours and six shapes

Figure 29, Newly designed terracotta jewellery in three colours and seven shapes

Table – 1 Colours obtained by single clay

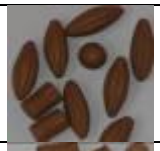
S No	Picture of beads	Location & RBG value	Remarks
Terracotta Beads in Shades of Brown			
1		Fine clay of Pawni **RGB : 93; 64; 42**	Very Dark Brown RGB : 92;64;51
2		Fine clay of Wardha **RGB : 107; 73; 48**	Semi-Sweet Chocolate RGB : 107;66;38
3		Fine clay of Khamaria **RGB : 116; 84; 56**	
Terracotta Beads in Shades of Orange			
5		Red coarse soil from Baswa, Rajasthan **RGB : 99; 41; 33**	
4		Fine Clay from Khairlanji **RGB : 109 ; 43; 30**	
6		Fine Clay from Bhankhed **RGB : 134; 74; 52**	Very near to Salmon4 RBG :139; 76; 57
7		Fine clay from Zadi District Gadchiroli**RGB:148; 77; 57**	Lighter than Salmon4 RGB : 139; 76; 57
Terracotta Beads in Shades of Grey			
8		Obtained from saw dust **RGB : 21; 21; 21**	Above to grey 8 RGB: 20; 20; 20
9		Obtained from horn **RGB : 11; 11; 11**	Above to grey 4 RGB: 10; 10; 10
Terracotta Beads in Shades of White			
10		Fine clay from Rajura **RGB:193;168;159**	Lighter than wheat3 RGB: 205;186;150

Table-2 Colours obtained by mixtures of clay

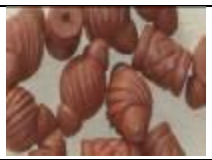
S No	Picture of beads	Location & RBG value	Remarks
1		Pawni + Zadi **RGB : 82; 38; 27**	Close to Black Brown RGB: 83; 37; 16
2		Pawni + Khairlanji **RGB : 94; 43; 22**	Close to Beiga Brown RGB: 94; 56; 22
3		Pawni + Khothurna **RGB : 111; 67; 38**	Very close to semi sweet chocolate RGB 107; 66; 38
4		Pawni +Khothurna + Rajura **RGB : 123; 68; 36**	Closer to Mocha wood RGB: 113; 71; 42
5		Pawni +Khothurna + Khairlanji **RGB :134;85;76**	
6		Pawni + Wardha +Rajura **RGB : 137; 94; 67**	Very close to Dark Wood RGB :133; 94; 66
7		Pawni + Rajasthan **RGB :141;91;74**	
8		Pawni +Khothurna + Zadi **RGB :144;99;84**	Very close to tan4 RGB :139; 90; 43
9		Pawni +Rajura **RGB 157; 106; 71**	Very close to dark tan RGB: 151; 105; 79

Table-3 Tints of Khairlanji fine clay

S No	Picture of beads	Location & RBG value	Ratio of clay	Remarks
1		Khairlanji **RGB : 109;43;30**	1 : 0	Very close to Beige Brown DK RBG:109, 66, 39
2		Khairlanji +Rajura **RGB : 131;69;56**	1:1	Close to Beige Brown MD RBG: 128, 85, 30
3		Khairlanji +Rajura **RGB : 149;97;84**	3:4	
4		Khairlanji +Rajura **RGB : 163;121;108**	1: 2	
5		Khairlanji +Rajura **RGB : 170;135;121**	1 : 4	
6		Khairlanji +Rajura **RGB : 180;152;141**	1: 8	
7		Rajura **RGB : 193;168;159**	0 : 1	

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