2011

"Inks in the Islamic Manuscripts of Northern Nigeria - Old Recipes, Modern Analysis and Medicine"

Michaelle Biddle, *Wesleyan University*

BRILL

Journal of Islamic Manuscripts 2 (2011) 1-35

brill.nl/jim

Inks in the Islamic Manuscripts of Northern Nigeria Old Recipes, Modern Analysis and Medicine

Michaelle Biddle
Collections Conservator and Head of Preservation Services
Wesleyan University Library, Middletown, Connecticut 06459, USA
e-mail: mbiddle@wesleyan.edu

Abstract
This study is concerned with what specific materials are used in fabricating the inks used in the surviving, largely undated Northern Nigerian manuscripts written in Arabic script. These manuscripts belong to the West African tradition of Islamic culture and scholarship, of which Timbuktu, Mali, was a key center. The manuscripts themselves, and 4500 km of road travel throughout Northern Nigeria, suggest a local tradition of dye, ink and pigment fabrication rather than one derived from the Mediterranean and the Islamic heartlands. Technical materials analysis, recipes from ethno-cultural studies, and replicative experiments revealed a reliance on local plants and materials. Botanical research uncovered a possible linkage between inks and medical treatments through the creation of charms in which ink was washed from the paper and drunk, or used as a body wash. They reflect a sustainable, durable and flexible tradition that overcame challenges of execution, using indigenous materials, astute observation, trial and error—a tradition documenting that people traveled as well as goods and ideas.

Keywords
Qur'ān, manuscripts, inks, pigments, botany, *malam*, medicine, charms, microchemical analysis, material analysis, ethnocultural, archaeology, replicative experiments, West Africa, Nigeria, Sudan, Bornu, Borno, Sokoto, Hausaland, Wesleyan University Library

Materials Analysis

The analysis of materials is increasingly being recognized as significant to both the preservation of the object and the knowledge we can glean from it. Islamic art historians such as the distinguished Oleg Grabar concede

> The study of artifacts and of the writing of books acts . . . as a sort of social science that introduces us to all levels of culture, and not just its masterpieces. In this

DOI: 10.1163/187846411X566869

Ink supplies—ground charcoal and gum in the foreground—for making the basic carbon ink used in *Qur'anic* schools. The reeds are for pen making. These supplies are sold to the *almajirai*, itinerant students. Kano Market 2008 (Photo by Michaelle Biddle).

> sense, it is a sort of archaeology of a type of document, comparable to the archaeology of sites . . .[1]

A great deal can be learnt about the availability of materials, technological capabilities of the society that produced the artifact, their trading links, and the wealth and status of the individuals who commissioned or made the object. Evidence for all these things can be found in the materials used. Africa is not a shadow of Europe and the Islamic world. It has its own history, its own culture and its own identity and should be studied on those terms. Any attempt to understand the inks used in these manuscripts requires the synthesis of scattered, often contradictory materials that cross disciplines. Some readers might call this a work in material culture, others might see it as historical archaeology but Northern Nigeria is a large area with a complex history. Research on this area has been undertaken by scholars working in several different languages, in a variety of fields, and their published works are widely scattered, many of which are not readily available. Nonetheless interdisciplinary convergences and borrowing have been a hallmark of Africanist scholarship.

Northern Nigerian Islamic Manuscripts

Manuscript books were imported from the Middle East and North Africa since the 10-11th centuries. They also were written and copied in the region. Many were primary texts of Islam—*Qurʾān*s and *Ḥadīth*—as well as devotional texts, canonical works of the Maliki school of Islamic law and Islamic science, including astronomy, mathematics and grammar. There were also numerous original works: poetry, historical chronicles, family genealogies, letters, contracts, commentaries and marginal notes. There are no extant written treatises from Northern Nigeria, or from sub-Saharan West Africa, on the procedures, materials and techniques used in their centuries-old indigenous codicology. Local Northern Nigerian knowledge of this tradition was fractured by the 1920s colonial introduction of *boko*, Hausa in Roman characters,[2] and the moderating factors imposed by a rapidly changing, sometimes violent and corrupt polity. Today traditional scribal traditions are still practiced by a few, although in a much attenuated form, in spite of competition from the printed word.

---

[1] Christiane Gruber (ed.), *The Islamic manuscript tradition. Ten centuries of book arts in Indiana University collections*. Bloomington, Indiana University Press, 2010, p. xii.

[2] A.C.G. Hastings, *Nigerian days*, London, John Lane, 1925, p. 163.

Northern Nigerian manuscript books are not bound. They are loose folios usually stored in leather wrappers and saddlebags. Unlike printed books, each manuscript is unique. Their significance lies not just in their content but also in their materiality, a materiality that betrays a mental structure or worldview. Embedded in these folios is evidence of patterns, of values, of thought, of behavior, of making, and of using. These manuscripts were produced by practitioners and document a process by which they constituted their cultural identities. These manuscripts were not experienced solely as linguistic signs. They might be about an idea or a mental construct, something symbolic or purely textual, but this construct relates to and emerges from a complex material infrastructure—people, compounds, walls, wells, fields, animals, plants, etc. The materiality of these social meanings is a contrast to the text with its reference to a wider world of ideas, thoughts and strictures. In a logocentric tradition, which Islam surely is, text and language renders the material as meaningless. There is a hierarchy of opposites—the material versus the immaterial—and a subordination of things by writing.

Writing = knowledge = power
versus
Illiteracy = ignorance = powerlessness

The text, objectified by ink on paper, embodies relationships and lineages of scholars, an *isnad*, a scholarly genealogy of psychological landscapes, rhythms that exist in different areas of life, fluidity, human activities connected to the rhythms of nature, which give shape and direction to human lives. These activities create and shape relations. Types of things such as paper and ink never exist in isolation but are part of a complex cultural ecology of material forms. These manuscripts are about people, embodying many different aspects of human activity—intellectual, spiritual, literary, ideological, artistic, historic, political, economic and emblematic.

They are windows to past lives, facilitating vital understanding between past, present and future. Whenever one survives time's scythe, it embodies a valuable testament of mute eloquence that can only be given voice by using multidisciplinary tools for a holistic study of the book as an object considering materials, techniques and practices. We need to acknowledge the potentially complex history of the book as an artifact in the period of its formation. Not only is the manuscript book a portable self-containing site for reading but, as an object, is a reflection of contemporary concerns and realities. The simple question, 'What is this object made from?', can open vistas of knowledge because the simple identification of material may have important ramifications.

Initiating the examination of any object is to understand their composition and the technology needed to produce the artifact. Understanding 'How does the society structure the making of things?' can lead us to knowledge of the calligrapher, the tanner, the weaver, the satchel maker as repositories of technical expertise and tradition. Examining how it is that the practitioners can sustain a certain visual look and homogeneity, in spite of political upheaval, challenging environment and a constantly changing community of practitioners, is to better understand patterns so subtle that those who recorded them did not always notice them. Understanding the subtle uses of these materials can lead to unforeseen revelations.

Northern Nigeria

Northern Nigeria lies north of Abuja and the Niger and Benue Rivers. Nigeria is a country delineated and named by the British, who ruled from 1903-1960. About 80% of the present population is composed of Hausa and Fulani in the north, Yoruba in the west and Igbo in the east. The Hausa and the Fulani are Muslim, the Yoruba and Igbo are animists as well as Christians. Some Yoruba are Muslim. The difference between the Islamic north and the Christian south is a line of division in today's Nigeria where there are more Muslims than in Egypt and Saudia Arabia combined.[3]

The history of Northern Nigeria—the historical polities of Bornu and Kanem, Hausaland, and the Sultanate of Sokoto, which extended beyond Nigeria's present borders—took place against the background of world Islam. They are as much a part of Islamic history as are the early Arab conquests or the rise of the Ottoman Turks. They can be understood fully only within the context of Islam, its political and cultural history. Sufi ideas and practices of mysticism, asceticism, *baraka* and miracles attributed to holy men were important in post-18th century Hausaland.[4] Islam and the Arabic language created a measure of pan-Islamic cultural unity throughout West and North Africa, the Middle East, Central Asia and India. Throughout the centuries transcultural interaction and integration occurred alongside contact, trade and conquests. Bornu and Kanem, adjacent to Lake Chad, whose rulers became Muslim c. 1000 AD, were undoubtedly the first areas where a teaching and

[3] www.factbook.net/muslim_pop.php—accessed 3 april 2010.

[4] M. Hiskett, *Sword of truth. The life and times of the Shehu Usuman Dan Fodio*. New York, Oxford University Press, 1973, p. 60. H.T. Norris, *Sufi mystics of the Niger Desert*. Oxford, Clarendon Press, 1984, pp. 126-149.

scholarly tradition developed in central Sudanic Africa.[5] Both Bornu and Hausaland were visited by peripatetic scholars from the major centers of learning in the western Sudan, North Africa, the Middle East and India. Arab chroniclers reported that scholars from Bornu and Hausaland went to Timbuktu and Cairo to study and teach.[6] They went on *ḥajj*. These scholars and pilgrims of Bornu, Kanem, Hausaland and the Sultanate of Sokoto created the manuscripts of Northern Nigeria, an artifact class equated with their Islamic cultural identity—manuscripts of ink on paper.

The Arabs called the land south of the Sahara Desert *Bilād as-sūdān*, the land of the blacks. It stretches from the Nile's west bank to the Atlantic Ocean. The Sahara gradually merges into the *sahel*, grassy steppe, then the *sudan*, broad savannah and woodlands. The term *sahel*, Arabic *sāḥil* for 'shore', is understandable if the desert is thought of as a sea of sand and the camel a ship.[7] Tropical rainforest or moist woodlands lie beyond, primarily hugging the coast. These different ecosystems are richly endowed with a wide variety of floral and mineral resources. The sudano-sahelian climate is one of harsh extremes—a very hot dry season characterized by daily abrasive *harmattan* dust storms, followed by a somewhat cooler wet season of daily torrential downpours.[8]

Life in the *Bilād as-sūdān* was, and is, challenging, subject to multitudinous ills including smallpox, eye diseases, and the ague that felled many early European travelers and delayed the conquest of Nigeria by the British. It is still home to polio and at least twenty-eight different strains of malaria. Its tsetse fly is notorious for the variety of diseases it transmits to both humans and animals.[9]

The topography, the shape and contour of its land, has profoundly affected its history. Environmental and geological diversity have resulted in disparate development and interaction. Whilst the Sahara is a barrier, what Bovill called 'one of the world's greatest barriers to human movement' there is evidence that

---

[5] J.O. Hunwick, R. Abubakre, H. Bobboyi, R. Loimeier, S. Reichmuth and M.S. Umar, *Arabic Literature of Africa*. vol. 2. *The Writings of Central Sudanic Africa*. Leiden, E.J. Brill, 1995, p. 2.

[6] N. Levtzion and J.F.P. Hopkins, *Corpus of early Arabic sources for West African history*. Cambridge, Cambridge University Press, 1981: Yaqut on p. 173; al-Umari on p. 260.

[7] N. Levtzion, *Ancient Ghana and Mali*. London, Methuen, 1973, p. 10.

[8] G. Connah, *African Civilizations. An archaeological perspective.* Cambridge, Cambridge University Press, 2001, pp. 108-115.

[9] A. Spielman, and M. D'Antonio, *Mosquito. A natural history of our most persistent and deadly foe.* New York, Hyperion Books, 2001.

that barrier gave way time and again. Representations of men riding in horse-drawn chariots or on cattle have been found in over three hundred Saharan rock art locations.[10] After the first expansion of the Arabs in the seventh century, Islam became common to most of North Africa and the Sahara and over the centuries diffused into the *Bilād as-sūdān*. The Muslim Arabs of North Africa effectively used the camel, first introduced by the Romans, to expand and regularize trade routes to the south in order to procure gold and slaves. Recent excavations at Essouk-Tadmakka indicate that trans-Saharan trade was well established by the mid-eighth century.[11] The penetration of Islam beyond the Sahara gave North Africans religious, cultural and commercial access into *sudano-sahelian* societies. Trade between the two sides of the Sahara was mutually beneficial and profitable whilst the limits of power between one side of the Sahara and the other remained in rough equilibrium until the 19th century.

The value placed on learning and literature, and the administrative needs of state bureaucracy, created an enormous demand for writing materials. Islamic culture is a logocentric one where there is a high value placed on words, particularly the words of the *Qurʾān*, with calligraphy a premier Islamic art form. Handwritten copies of the *Qurʾān* were, and still are, revered. In Kano selling a manuscript *Qurʾān* was a rite of passage that signified becoming a *malam*,[12] traditionally a man well versed in Islamic religious knowledge, a Muslim scholar, a scribe, a teacher and/or a supernatural expert. In the early 15th century Al-Qalqashandī's comments on letters from Bornu's *Mai* (king) to Mamluk Sultan Barqūq in Cairo illustrate that Bornu could draw on the services of sophisticated scribes.[13] By the 16th century a copying industry flourished in Timbuktu, the intellectual and spiritual heart of Islamic West Africa, with copyists, proofreaders and editors being well known for their skills.[14] The profession of *malam*, as manuscript copyist and calligrapher, came to flourish among the literate class in Bornu and Kanem and Hausaland, satisfying the

[10] E.W. Bovill, *Golden trade of the moors.* New York, Oxford University Press, 1968, pp. 13-27.

[11] S. Nixon, 'Excavating Essouk-Tadmakka (Mali). New archaeological investigations of early Islamic trans-Saharan trade', in: *Azamia. Archaeological Research in Africa* 44 (2009), pp. 217-255.

[12] N. Skinner (ed.), *Alhaji Mahmudu Koki. Kano malam.* Zaria, Nigeria, Ahmadu Bello University Press, 1977, p. 29.

[13] Levtzion & Hopkins, *Corpus*, pp. 346-347.

[14] G. Lydon, 'Inkwells of the Sahara. Reflections on the production of Islamic knowledge in *Bilad Shinqit*', in: S.S. Reese (ed.), *The transmission of learning in Islamic Africa*. Leiden, E.J. Brill, 2004, pp. 39-71.

need for books[15] with printing not replacing manuscript copying in a significant way until the 1930s.[16]

Ink

The ink used in Northern Nigerian manuscripts has been described as 'brown with rubrication',[17] 'black vegetable'[18] or 'ferro-tannic'.[19] But what is ink? It is best described as a colored solution, prepared from dyes or from finely grained pigments with strong coloring power. A dye is a water soluble substance, mostly of organic origin. A pigment is a non-soluble colored compound. Pigments are often inorganic in origin, such as earth pigments or ochres. Dyes used as ink and pigments can be bound onto the surface of paper fibers by means of a binding medium such as gum. The major concern is that ink flow evenly so the lines from the pen, or brush, are controlled, producing uninterrupted lines or strokes. Throughout the world carbon inks were probably the first writing inks, using finely ground charcoal, soot, lampblack from burning oil or resin, in spit or water.

Examination of over twelve thousand Northern Nigerian folios revealed a very wide range of ink colors, from glossy dense black to very pale light brown, orange red to pale pink, some opaque whilst others faint and transparent, some stained the paper whilst others had rough particulates. Some inks are barely darker than the brown paper on which they are found. A minority of inks corrode the paper substrate. Only *Qurʾān*s, or portions from the *Qurʾān*, have decorations or designs—in Hausa *zayanna*, in Fulfulde *fawne*—and those are usually in red and yellow-brown, sometimes a dark purple brown. Lemon-yellow and green are rarely encountered. Not one example of blue ink or pigment was uncovered in the fourteen Northern Nigerian collections examined, remarkable in an area renowned for the antiquity of its indigo dyes. There is no one typical ink but there appear to be five main types:

---

[15] S.E.M. Hassan, *Lore of the traditional malam. Material culture of literacy and ethnography of writing among the Hausa of Northern Nigeria*, Philadelphia, University of Pennsylvania, PhD thesis, 1988, p. 31.

[16] Skinner, *Alhaji Mahmudu Koki*, p. 35; Hassan, *Lore of the traditional malam*, p. 193.

[17] M. Hiskett, 'Material relating to the state of learning among the Fulani before their Jihad', in: *Bulletin of the School of Oriental and African Studies* 19 (1957), p. 550.

[18] M. Hiskett, 'The Arab star-calendar and planetary system in Hausa verse', in: *Bulletin of the School of Oriental and African Studies* 30 (1967), p. 158.

[19] M. Last, 'The book in the Sokoto Caliphate', paper delivered at Arewa House Conference 7-8 March 2007.

- carbon blacks
- soot browns
- dyes
- ferro-tannics
- colloidal suspensions (pigments)

The only writing instruments used were reed pens with nibs in various thicknesses. A separate pen would have been used for each color of ink but text was written and designs were drawn by the same person.[20]

Identification Methods

Surface microscopy in the field was conducted with a 30x Mikro Lupe FF-393 and a 10x Eschenbach Lupe Series 1510-1004. Some chemical and polarized light microscopic identification methods required the sampling of minute amounts of materials. Samples for these methods were taken from unattached, discarded manuscript crumbs, which due to their minute size (<1cm) could not be matched to a folio parent.

Gum

Surface microscopic examination in the field revealed many inks and pigments with fine spider web craze lines indicative of heavy additions of gum. *Acacia farnesiana, nilotica, polyacantha, senegal, seyal*, and *sieberiana* are the gum producing trees that grow across Northern Nigeria. *Acacia nilotica* and *senegal* are the ones most commonly used but Northern Nigerians divide gum into three classes—*falli*, white or colorless *marua*, tinted yellow or reddish *mumuye*, dark or lumpy—and when purchased in the market they might contain admixtures, sometimes with more readily obtainable bulking additives.

Red Ink

Microscopic examination of some red inks revealed particulates of various sizes, whilst others exhibited characteristics of dyes. In red particulate inks, hematite, the colorant in iron oxide red, was identified by its microscopic appearance. Finely prepared hematite and vermillion can show similar microscopic appearance even under polarized light microscopy but vermillion is soluble in hydriodic acid and hematite is not. More than three dozen samples

[20] Skinner, *Alhaji Mahmudu Koki*, p. 28; Hassan, *Lore of the traditional malam*, p. 178.

with red particulates were tested with hydriodic acid. None were soluble, confirming iron oxide red or hematite.[21]

Yellow Ink

Microscopic examination of opaque yellow pigments revealed iron oxide yellow and tested positive for iron with potassium ferrocyanide.[22] These pigments chemically tested negative for arsenic[23] eliminating the possibility of realgar ~ 70% arsenic, or orpiment ~ 60% arsenic. Organic yellows were identified by the stain-like appearance characteristic of a dye. Biuret tests on glossy yellow ink flakes yield one positive for protein, indicating the possible use of egg yolk or egg white as a pigment binder since animal glues were not traditionally used in Northern Nigeria. The use of egg yolk may have initially intensified the yellow color in an organic dye.

Black and Brown Ink

The true black inks were identified with polarized light microscopy as carbon blacks. Carbon inks were indicated by the presence of finely divided opaque particles as seen microscopically but the particles were neither so fine nor even as in a lampblack type. The source of lampblack inks would be a burned oil, sap or oily seed. Some of these Northern Nigerian black inks have a very dark purple aspect indicating a manganese oxide or hydroxide additive. Some brown and brown-black inks exhibited characteristics of a dye but some tested positive for iron with potassium ferrocyanide. A soot based brown or brown-black ink was the most commonly encountered ink with particulate size and opacity varying widely.

Qurʾānic Decoration

The favored red and yellow pigments encountered in *Qurʾān*s came from colored minerals, such as ochres—iron oxides red, yellow and sometimes purple brown—which would have been ground and sieved to convert them into pigments. Iron oxides can range in color from a clear yellow, orange, red and purples. Through levigation—wet grinding—and decantation these colored

---

[21] R.J. Gettens, R.L. Feller and W.T. Chase, 'Vermillion and cinnabar', in: *Studies in Conservation* 17 (1972), pp. 45-69.

[22] R.J. Gettens and G.L. Stout, *Painting materials. A short encyclopaedia*. New York, Dover Publications, [1942], 1966, reprint, p. 134.

[23] C. Hawks, www.ellencarrlee.wordpress.com/2009/01—accessed 1 April 2010.

minerals can be homogenized into finer products. These processes can be repeated, resulting in different shades of a color, colored from deep and bright to pale and thin, with the finest pigment particles used in suspension in gummed water as ink. Depending on the thickness of the gummed water, the solution could be used either as ink or pigment. Red, yellow and purple-brown ochres were the source of every red, yellow and purple-brown pigment tested in Northern Nigerian Qur'ānic decoration, even though realgar and orpiment were known and widely used elsewhere in the Islamic world.[24] These results counter Brockett's assertions that realgar and vermillion were used in Leeds Arabic ms 301 and Leeds University ms 619 and that they are from Bornu. Brockett's conclusions were based on visual inspection and beta-radiography, a method more commonly used for recording paper structure and watermarks.[25]

Ochres are variably colored rocks and soils primarily composed of oxides and hydroxides of iron. Red ochres contain hematite, yellow ochres goethite and purple-brown manganese oxide or hydroxide. They can be very pure but more typically contain other minerals such as clay or micas. They can range in color from bright yellow, orange, red and purple. Their precise composition, color and working properties are locally specific but in the iron rich earth of Northern Nigerian a wide range of ochre colors are easily found.

XRF and Raman

The destructive nature of chemical tests, which have been impediments to ink and pigment identification, are now being overcome by advances in scientific instruments. Two privately owned manuscript pages were tested with Raman microscopy (Thermo Scientific NXR FT-Raman) but results were inconclusive due to the lack of a relevant, i.e. West African, reference library. This is

[24] M. Levey, M. Krek and H. Haddad, 'Some notes on the chemical technology in an 11th century Arabic work on bookbinding', in: *Isis* 47, pp. 239-243. M. Levey, 'Medieval Arabic Bookmaking and its relation to early chemistry and pharmacology', *Transactions of the American Philosophical Society*, New Series Volume 52, Part 4. Philadelphia 1962; G.D. Lowry, M.C. Beach, R. Marefat, and W.M. Thackston, *An annotated and illustrated checklist of the Vever Collection*. Washington, D.C., Smithsonian Institution, 1988, pp. 425-428; W.M. Thackston, 'Treatise on calligraphic inks. A disquisition on paper, colors, inks and pens by Simi of Nishapur', in: *Intellectual Studies on Islam. Essays written in honor of Martin B. Dickson*, Salt Lake City, Utah, University of Utah Press, 1990; Ibrahim Chabbouh, 'Two new sources on the art of mixing ink' in Yasin Dutton (ed.), *The codicology of Islamic Manuscripts. Proceedings of the second conference of Al-Furqan Islamic Heritage Foundation 1993*, London, Al-Furqan Islamic Heritage Foundation, 1995, pp. 59-76.

[25] A. Brockett, 'Aspects of the physical transmission of the Qur'ān in 19th century Sudan. Script, decoration, binding and paper', in: *Manuscripts of the Middle East* 2 (1987), pp. 45-67.

disappointing because Raman can be used to distinguish organics even though Raman is limited in its analysis of pure black inks and pigments due to black absorbing light and Raman's analysis dependent on reflectance. XRF (X-ray fluorescence) spectroscopy (Thermo Scientific Niton XL3t) on the same two folios confirmed the identification of iron in the red inks and carbon in the black ink. XRF does not analyze organics and its results can be affected by pH, concentration of the colorant and method of preparation.[25a] This equipment is not available in Nigeria but its use in analyzing the components of these inks is moot given the present lack of a relevant reference library.

Ethnocultural Ink Recipes

Under these circumstances, microchemical testing yields an incomplete picture of materials and methods used in ink fabrication. Reconstruction of materials and processes of manufacture can lead to a critical understanding of technological know-how and insight, an intangible cultural heritage that exists, as in the case of inks and pigments used in these manuscripts, only in practice. Only rarely are such traditions continued in the modern era but clues to ink components and ink recipes were found embedded in published language dictionaries, ethnographies and contemporary family lore.

– Charles Kingsley Meek (1885-1965) joined the British colonial service and was posted to northern Nigeria in 1912 as Government Anthropologist. Fundamental to the British policy of indirect rule was a systematic understanding of traditional institutions. Meek's ethnological studies led to his 1925 publication, *The Northern Tribes of Nigeria*, in which is recorded a single ink recipe in the chapter on 'Sylvan Produce'.
– Alhaji Mahmudu Koki (c. 1895-1976) was a fifth generation Kano *malam*, who had assisted George Percival Bargery (1876-1966) during field work on the monumental *Hausa-English and English-Hausa dictionary* [1934], which is itself a source of information on traditional scribal traditions. Neil Skinner recorded and translated Malam Koki's recollections of his life in 1967. Thirty years later Skinner published his *Hausa comparative dictionary* [1996], which includes connotations, extensions of meaning, as well as words in other languages which are similar in form or meaning.

[25a] M. Clarke, 'Limitations of, fluorescence spectroscopy…' in: van Grieken *et al.* (eds.), *Art 2002*, Congress Centre Elzenfeld, Antwerp.

– Recipes were collected from Kano malams active in the 1980s by Salah E. Mohammed Hassan [1988] for his unpublished Ph.D. dissertation.
– Recipes were collected during my three 2008-2009 research and teaching tours.
– Lists of ink ingredients are found in some plant listings (see Appendix 1) in the monumental work of botanist Humphrey Burkill, *Useful Plants of West Africa*, London, Kew Gardens, 1985-2000.

Meek Recipe[26]

'There are many gum trees, notably *Anogeissus leiocarpus* (*marke*), the *Acacia Sieberiana* (*fara kaya*)… provide the gum used in making ink. The gum is mixed with water, boiled, and stirred. Leaves of the *Vitex cienkowski (dinya)* are also boiled in a separate pot and mixed with the gum. Both are then again boiled together, and a black ink is the result.'

Each plant found to be used in inks is listed in Appendix 1 and has been given a BL number for precise reference. There are dialectical differences in Hausa and Fulfulde and thus transcriptions vary even without the complications of hooked letters. For instance *marke* (BL8) is also spelled *markee, fara kaya* (BL32) *farar kaya, dinya* (BL62) *dinyaa* and *dunyaa*. Roger Blench's online sites (internet addresses provided at the end of Appendix 1) currently provide the most complete list of variant Hausa and Fulfulde names for plants and trees.

Koki Recipes[27]

Dake: 'Here in the City we do not have trees, we burn *keso* and grind it and grind it and grind it. Then you add gum… knead it into a ball… soak it… add more gum-arabic… There is your ink… out in the country they prefer making it with the leaves of the *dinya*… when the young shoot come, they pick these and put them in a cooking pot and cook them, cook them, cook them until they boil hard. Then the pot is taken off and allowed to cool, and then poured into the inkpot and gum-arabic added.' *Keso* is a grass mat of the type used to sew up cowries—usually 10,000 cowries per mat. *Dinya* (BL62) is an African tree, *Verbenaceae Vitex doniana*, with a black plum-like fruit used

[26] C.K. Meek, *The northern tribes of Nigeria*, London, Frank Cass & Co. [1925], 1971 reprint] vol. 1, p. 147.
[27] Skinner, *Alhaji Mahmudu Koki*, pp. 36-38.

in making *maʾdi*, a sweet drink that can also turn alcoholic. Bargery records *dake* as an ink made from scorched *gandagaura*, a kind of guinea corn.

Wanke: '… take a little water in an earthenware pot or in a wooden bowl and then go from compound to compound … the women … will turn her cooking pot over and there is all the soot on the outside and you rub and rub with your hand and then wash it in the water. Then you rub the wetted pot again and again and wash our hand again until the water gets thick. Next you take a skewer and test the water to see if it is black enough. Then you add gum Arabic and cook it until it boils. When it has boiled and cooled, you take it and pour it into an inkpot.'

Zube: 'For this the wood of the desert date is burnt. When it is burning really well and has hot embers, well alight, it is quenched with water … you have charcoal … and rub it with a stone. You find a smooth stone and rub and rub and all the while the powder is coming off … that one too you mix up with water and gum Arabic. That is the best sort of ink, the one made from the wood of the desert date … ' The desert date is *Balanitaceae Balanites aegyptiaca*, the Hausa *aduwa* (BL2). In English this tree is the soapberry tree, or thorn tree, with the dried fruit, the desert date. This tree is not to be confused with the date palm, *Palmae Phoenix dactylifera*, or the desert palm, *Palmae Borassus aethiopum* (BL49).

Tsume: 'Tsume is also called *yambari* and is made by collecting slag and a lump of iron … and putting them into a cooking pots. Next you pick some of the fruit of a *gabaruwa* and put that in too. Then when you've got the three of them, the slag, the iron and the *gabaruwa* fruit, you pour water on to them until it covers them. Leave that for three or four days and it will get black. Then if you add gum Arabic, that is what the people who write the *Qurʾān*, or write books, or write on paper use.' *Gabaruwa*, also spelled *gabarawa*, is the tree or pods from *Leguminosae: Mimosoideae Acacia nilotica* (BL28), known from ancient times as a source of tanning materials.

Koya: 'To write the vowels in red, we use *koya* … from a sort of stone … rubbing it down … Also we can get a certain type of earth … from a town in Damagaram district called Ilella … *Ilella koya* … it is a good sort which is sold for a high price. There is store *koya* too, but the red of that sort is too bright. We prefer the appearance of our old, traditional sort for writing *Qurʾān*s.' *Koya* is a processed red earth (iron oxide red or red ochre) kneaded into gum, the ingredients of which can be collected easily all across Northern Nigeria

since the soils are strongly impregnated with iron oxides. *Koya*, known as *karo* or *eroo* in Muslim Yorubaland, was a 19th century trade item with Nupe and Ibadan.[28] Ilella earth, another iron oxide red, was a trade item brought through Damagaram, now in Niger, a Sultanate founded by Muslim Kanuri's from Bornu during the 18th century. Ilella is due north of Sokoto.

At the Katsina History and Culture Bureau an old dusty dry bottle of Rowney Kandahar Waterproof Drawing Ink Made in England, was produced. This is possibly the 'store koya' to which Malam Koki refers. Rowney has been producing artists' colors since the early 19th century and their products would have been available during the British colonial period. After adding water to the dried ink flakes, bright pinkish red lines, of the type seen in early 20th century *Qur'ān*, were produced. The staff recounted that the color was disliked so no one used it. Hassan and Skinner also recorded the general dislike for this pinkish-red colored ink.[29]

Hassan Recipes[30]

Tawada: '…washable ink… black or dark brown type is made by extracting the accumulated soot on cooking pots. Sometimes the soot is washed into water directly… Crushed gum Arabic is added and the whole solution cooked for some time. In some cases the solution is allowed to ferment for a couple of days… left to dry and rolled into little balls. These balls can be diluted and used as ink any time… black or brown ink is made from the leaves of… *dinya*. The leaves are collected in a pot filled with water and cooked for long time. After it is cooled, gum Arabic is added and the purified solution is poured into inkpots.'

Zube: 'A similar type of ink is made by using powdered charcoal instead of soot. This charcoal is traditionally prepared by burning the wood of the desert date and powdered by rubbing it with a… stone… has a smooth surface. The powder itself is filtered again by using a fine type of textile… considered a luxury item… preferred type for writing the *rubutun sha*… which… is washed off to drink as a medicine or a blessing.'

---

[28] I.A. Jomoh, 'The art of Qur'anic penmanship and illumination among Muslim scholars in southwestern Nigeria', in: Fahmida Suleman (ed.), *Word of God, Art of Man. The Qur'an and its Creative Expressions. Selected Proceedings from the International Colloquium London, 2003*. Oxford, Oxford University Press, 2007, pp. 175-189.

[29] Hassan, *Lore of the traditional malam*, p. 142; Skinner, *Alhaji Mahmudu Koki*, p. 38.

[30] Hassan, *Lore of the traditional malam*, pp. 154-155, 174, 196.

Koya: '…vowels, diacritical marks, punctuation, or stops. For such purposes… a red, yellow or green color is normally used. Traditionally, these colors are locally made from plants or earth. The red ink is obtained from a certain stone known in Hausa as *koya*… The stone is prepared the same way… for soot or charcoal ink, by adding gum Arabic and cooking the solution or letting it warm under the sun. Another type of stone which can also produce the red ink is known as *magar*. The yellow (ochre) is also obtained from certain stones and sometimes roots of certain local plants.'

Alli: '…a special solution of crushed chalk or other type of clay dissolved in water… It is usually applied on *allo* after being washed off from writing. When it dries it give a white writing surface.'

Tsume, Yambari: '…starts by obtaining some chips of wood or chaff of millet and, most importantly, the fruit (pods) of… *Gabarawa* (Acacia Arabica) (*sic*). These are collected in a cooking pot, to which water is added. This mixture is left to boil over a hot wood fire for… two to three hours. Then slag from blacksmith workshops is added. Sometimes any rusty metal or piece of iron or old useless tool are also added. Gum Arabic is then added and the whole solution is left on the fire for hours (sometimes one to two days). The whole mixture is then filtered, left to cool, and poured into ink pots or small glass bottles. Depending on the time, degree of boiling and proportions of the mixture, different shades of color can be obtained… to obtain colors such as green or red imported dyes are added.' The *Acacia arabica* is the gum producing tree of India and does not grow in West Africa. The source of *gabarawa* is *Leguminosae: Mimosoideae Acacia nilotica* (BL28).

Asiri: 'Most *malams* are willing to speak about all matters… except the healing and magical… ', i.e. charms.

Biddle Recipes

From Yola, Adamawa.

Malam Garba—A family recipe for writing on paper from Malam Abdullahi Adamu Garba, who called this *tawada.* Bargery calls this type of ink, *dake.*[31]

'Cook guinea corn until it is black and dried. Then grind it and grind it. Throw it in water with gum and cook it some more.'

---

[31] G.P. Bargery, *A Hausa-English dictionary and a English-Hausa dictionary.* Oxford, Oxford University Press, 1934, p. 196.

From Sokoto
Malam Buhari—A family recipe for *tsume/yabari* from Malam Aminu Buhari, who furnished me with the ingredients in what he said were the right proportions although he did not weight them but instead 'measured them in my hand'. The ingredients were later weighed on a digital scale.

32 grams red weed *Striga sengegalensis—kuduji*, *gogai* or *gaugai, marin gona, yaryadi*
24 grams dross—*kankarin*
25 grams *acacia* seed pods
25 grams gum

'Cover them in some water for a couple of weeks. When it is black enough, strain it and put it in a pot. It keeps longer in a plastic bottle with a stopper.' *Striga sengegalensis*, renamed *Striga hermontheca* by the International Plant Names Project [www.ipui.org], is a common pink flowered witchweed, which can decimate sorghum (guinea corn) and millet crops. *Kankarin* is slag, a by-product of iron smelting. The acacia seed pods provided were from *Acacia nilotica* (BL28). Around Sokoto there are large plantations of *Acacia nilotica* maintained in support of Sokoto's tanning factories.

Whilst walking along the drainage ditch adjacent to the new Uthman DanFodio University Library in Sokoto I was told that the water scum would make a good ink. In Fulfulde this type of ink is called *kaduum*. Another student volunteered that good ink could be made by burning the seed pods of tree cotton (BL43). There were miscellaneous comments that ink could be made from the bark of several trees, tree leaves, *gabarawa* pods (BL28) will make the ink permanent, and that the addition of desert dates (BL2) makes ink dark and permanent.

Replicating Ethnocultural Ink Recipes

To confirm that a recipe resulted in an ink usable with a reed pen and to determine what conclusions or characterizations could be made of range and diversity of technological practice from the process of replication, several of these ink recipes were fabricated using smooth grinding stones from Mandara, Maidugurian earthenware pots and Nigerian bottled water with a ph 7-7.5. *Marua* gum was obtained in the markets of Sokoto, Kano and Maiduguri. White *karaya* gum (BL59) was collected directly from a tree in Yola. Botanical

materials were collected directly from the plant except for turmeric root which was purchased in Kaduna market. Red colored ochres were obtained whilst on walks in Mandara, yellow ochres near Katsina and pond scum in Sokoto. Since the recipes using plant ingredients all used a basic crushing of ingredients followed by lengthy boiling regime, this is the method followed in these replicative experiments.

Red Ink

Kaduum ink from pond scum was transparent, with no visible particulates when examined under 30x surface magnification. The quality of red ochre *koya* ink was directly dependent on the effort and repetition in pulverization, levigation and decantation. It could be coarse with gross particulates or made fine enough for use in making diacritical marks with a 1mm nib reed pen. Red ink was easily made from an aqueous leaf extract dye, *karan dafii*, of the ubiquitous guinea corn (BL17).

Black and Brown Ink

Boiled plum leaves, *dinya* (BL62), produced glossy black ink that stained the paper fibers. However when kept in an open container at Kaduna in April, the ink supported abundant mold growth within two days. Charcoal from the desert date (BL2) could be ground into extremely fine grained black carbon ink, *zube*. Zube was also extremely water soluble and easily smeared with sweaty fingers. Malam Buhari's *tsume/yambari* recipe with witchweed yielded a light-brown ink that was insoluble in water or alcohol. Soot based inks, *tawada/wanke*, varied in color from yellowish-brown to dark brown depending on the wood that had been burned. If the cooked soot water was strained through a fine cloth the result could be made particulate free.

Yellow Ink

A boiled aqueous turmeric (BL63) extract of shredded root and *karaya* gum (BL59) made bright yellow-brown mucilage that on drying shone. When exposed to moisture this dried ink became tacky and stuck to adjacent paper, a result seen in several manuscripts in Yola, which is on the Benue River. Yellow *koya* was made from sandy yellow ochre obtained near Katsina using the same process as for red ink. It produced yellow-brown ink. Turmeric and the Katsina yellow ochre produced inks that were quite similar in color. *Rawaya* or *raawaya* is both the Hausa word for yellow and the name for

Cochlospermum tinctorium (BL7), a source for yellow dye.[32] The Fulfulde call this dye *ooldina*.[33] An aqueous extract from macerated roots produced a clear yellow liquid the same shade as its buttercup yellow flowers.

Ferro-Tannic Ink

The simple fermentation of *Acacia nilotica* pods (BL28) in iron water resulted in a ferro-tanic dye where the iron salts turned black when exposed to the tannins in the *nilotica* pods. This dye is common in Fulani textiles.[34] Iron tannate dyes corrode cellulose but heavy additions of gum are now known to protect paper from this degradation process.[35]

Desert date (BL2) wine was made from fruit pulp using methods described by Battcock and Azam-Ali.[36] Within twenty-four hours it oxidized into vinegar to which rusty iron pieces were added. Concurrently crushed *Acacia senegal* (BL30) seed pods were soaked in enough water to cover, adding water as necessary to keep the pods covered. After two weeks strained out solids, including abundant mold growth, in both mixtures, combined the results and then added *marua* gum—by volume one part ground *marua* to four parts solution. The resulting ink was a rich, dark rusty-red brown-black color that aggressively bit into c. 1780 Italian paper and could not be washed off.

Utilizing Local Resources

Since the majority of examined inks were basically dyes and ethnocultural recipes used botanical ingredients, the six volume compendium *Useful Plants of West Africa* was consulted. Kew Gardens botanist Humphrey Burkill synthesized information recorded in several hundred sources compiled over the last century. He indexed over 400 plants used in inks or dyes. If Nigerian Hausa, Fulfulde or Kanuri terms for the plants were found, and the explanatory

---

[32] Bargery, *A Hausa-English dictionary*, p. 848; N. Skinner, *Hausa comparative dictionary*, Köln, Rüdiger Koppe Verlag, 1996, p. 217.

[33] P.K. Eguchi, *An English-Fulfulde dictionary.* Tokyo, Institute for the Study of Languages and Cultures of Asia and Africa, 1986, 'ooldina'.

[34] C.E. Kriger, *Cloth in West African History*, Lanham MD, Altimira Press, 2006, pp. 78-92.

[35] C. Remazeilles, V. Rouchon-Quillet and J. Bernard, 'Influence of gum Arabic on iron gall ink corrosion. Part 1: a laboratory samples study', in: *Restaurator* 25/4 (2004), pp. 220-232.

[36] M. Battcock, and S. Azam-Ali, *Fermented fruits and vegetables: a global perspective.* Rome, Food and Agriculture Organization of the United Nations, 1998, chapter 4, pp. 9-10.

text revealed potential ink use, they are included in Appendix 1. This list and chart of sixty-three species or genera (BL36 represents at least sixteen different varieties of indigo found in Northern Nigeria) each of which produce dyes, tannins, or additives of potential use in ink making.

Appendix 1, Chart 1, illustrates Burkill's description of their use as dyes, inks, tannins, gum, medicinal or alcohol. 71% of these botanical resources could be used as dyes and another 46% as tannins or mordants. Tannins and mordants enable a dye to be fixed to a material for which the dye has no affinity. Until the 20th century every village and town in Northern Nigeria had dye pits.[37] As students traveled from scholar to scholar during their peripatetic advanced education, they would also rely on the dyer's knowledge of organic dyes derived from colored plant extracts such as sorghum (BL17) and red woods (BL20) for red ink, or spices such as turmeric (BL63) and pomegranate bark (BL18) for yellow ink. The scholar might depend on ink balls, pomegranate twigs (BL41) for yellow or *jinin mutum* roots (BL4) that he had carried with him for red. Or depending on circumstance, dyes such as brown from cooking pot soot or red from sorghum (BL17), could be added to basic carbon inks to modify ink color.

These dye based inks could also be modified by the addition of tannins or mordants and in a society noted for its textiles—Nigerian dyers claim that Kano's Kofar Dye Pits date to 1498—such dyers knowledge would be profound. The dyers had demonstrable knowledge of iron smelting by-products, tannins and mordants to intensify color, improve the ability of the paper fibers to take up the dye and to hold it. Koki and Hassan's *tsume/yambari* recipe, in Fulfulde *ndolla* is of this type and it combines dye, tannins and mordants all in the same ink recipe and is dependent on the dyers' craft knowledge.

Dyeing with indigo, a notoriously complex procedure, is a centuries old craft in Northern Nigeria. Whilst the scribes and manuscript painters in Egypt, Persia and India, with their broad knowledge of ink and pigment ingredients, used indigo 'to embellish their texts and to enliven their blacks'[38] no ink in Northern Nigerian manuscripts possesses its distinctive blue-black aspect. Nor was blue pigment or ink in any shade found in any manuscript pre-1900, when the British imported commercially made inks. A dye obtained by fermenting and/or oxidation of the extracted colored liquid, indigo production is a complicated process and one that was possibly kept secret by

[37] H. Barth, *Travels and discoveries in north and central Africa… in the years 1849-1855.* New York, Harper and Brothers, 1857, vol. 1, pp. xv, 498; Meek, *The northern tribes of Nigeria*, vol. 1, pp. 160-163; O. Temple, *Notes on the tribes, provinces, emirates and states of the northern provinces of Nigeria*, New York, Barnes and Noble, [1922], 1967 reprint.

[38] J. Balfour-Paul, *Indigo in the Arab World*, Richmond, Curzon Press, 1997, p. 170.

those who knew how to manipulate it. Women wore wrappers dyed blue and dyed their hands, arms, feet and legs with indigo. Men, 'very fond of dress display', wore tobes dyed blue.[39] Therefore the *malams* of Bornu, Kanem and Sokoto-Hausaland may have preferred to embellish the sacred Qur'an with colored pigments—red and yellow and purple brown—that were not so commonly encountered in everyday life[40] even though blue is a common color in *Qur'ān*s from the Islamic heartlands.

From North Africa and the Islamic heartlands, peripatetic scholars from Northern Nigeria would have brought back more complex recipes for iron-gall inks, an ink, known since the days of Pliny the Elder (23-79 AD). These inks derive their color and intensity from a chemical reaction rather than a dye or a pigment. The advantage of these ferrous inks is that they are permanent inks that cannot be washed off the substrate. They literally burn into wood, papyrus, parchment or paper. The very word 'ink' is derived from the Greek *enkaustos*, the perfect participle of the verb meaning 'to burn in'. Initially ferrous inks will be black but over time they change to the brown, red-brown or even yellow we see today in Western manuscripts. This type of ink can destroy the fibers of the paper but generally that happens decades after the manuscript has been written. These iron-gall inks were made from gall nuts, excrescences formed on young trees or twigs by various insect species, and iron or copper sulphate. Crushed gall nuts in water were the source of gallo-tanic acids.

In Northern Nigeria only the tamarisk (BL61) has gall nuts but tamarisk galls are not mentioned in ethnocultural studies. Gallic acid is present in *noonon kurciyaa* (BL12) but the latex in which it is present does not readily dissolve in water, instead it becomes fibrous, making its use in ink improbable. However, there are twenty-nine Northern Nigerian plants recorded as being sources of tannin (Appendix 1 Table 1). A common and well-known use is in leather tanning[41] a craft for which the Hausa have been vaunted masters since the days of the 16th century Leo Africanus.

The other ingredient, ferrous sulphate, FeSO4, had been known in the Mediterranean since ancient times as copperas or green vitriol. There is no

---

[39] D. Denham, H. Clapperton and W. Oudney, *Narrative of travels and discoveries in central Africa in the years 1822, 1823 and 1824.* London, John Murray, 1826, Clapperton's narrative pp. 9, 17, 61; Barth, *Travels and discoveries*, vol. 1, pp. 269, 520; G. Nachtigal, *Sahara and Sudan* II*: Kawar, Bornu, Kanem, Borku and Ennedi* (A.G.B. Fisher and H.J. Fischer, transl.), London, C. Hurst & Co., 1980, pp. 181-186.

[40] J. Bousfield, 'The world seen as a colour chart', in: R.F. Ellen and D. Reason (eds.), *Classifications in their social context*, London, Academic Press, 1979.

[41] M.J. Lamb, 'The Hausa tanners of Northern Nigeria', in: *The New Bookbinder* 1 (1981), pp. 58-62.

evidence for equivalent Hausa or Fulfulde terms. However the Fulfulde have a word for iron water, *ndo'irigam* or *do'iriijam*, which could be used as a substitute for ferrous sulphate. This can be made by adding iron and vinegar to water and allowing the mixture to stand for a couple of weeks. Replicative experiments illustrated that a vinegar from desert dates, combined with rusty iron, a fine rich dark brown ink results, the ferrous oxide in rust combining with the high sulfur content in dates, resulting in a ferrous sulphate solution. *Ndolla* is a Fulfulde ink made from water in which old clinkers and or locust bean tree pods (BL11) have soaked. This pragmatic adaptation betrays a deep understanding of iron's reactive qualities coupled with a thorough knowledge of the components in indigenous botanical resources. Although the prevailing theory[42] about the origin of sub-Saharan iron metallurgy is that the technique spread from Carthage or Meroe, recent archaeological research has yielded dates that possibly point to an independent discovery in the region with Nigerian metallurgical sites dating to the second millennium BC.[43] This type of ink suggests a long familiarity with iron and its characteristics, and livelihoods characterized by skillful utilization and adaptation to environment and microenvironments.

Students in elementary Qur'ānic schools used, and continue to use, the most basic of all inks.—ground charcoal, water and gum. These ingredients are currently for sale in the markets of every major city in Northern Nigeria. An easily prepared, easily erasable ink, it is ideal for the use on the *allo*, wooden slates, used in these schools. Ethnocultural recipes revealed that ground charcoal could come from the burning of *keso*, a grass mat of the type into which cowries were sewn. If the charcoal came from *keso* or was coarse, the ink was usually called *tawada*, the basic Hausa term for ink. This type of ink can be made into dry balls, *tunkulen tawada*. If the charcoal came from the desert date (BL2) the ink was usually called *zube*. These distinctions were recorded by Bargery and still hold true today.[44] Examination of old *allo* and manuscript folio confirms the use of coarse carbon *tawada* on *allo* and refined lampblack-like *zube* on paper.

---

[42] G. Connah, *Transformations in Africa. Essays on Africa's later past*. London, Leicester University Press, 1998.

[43] J. Ameje, Traditional iron working in parts of the 'Nok Culture' area. Notes and posers from preliminary investigations. Abuja, National Commission for Museums and Monuments, Abuja, Nigeria, 2008. http://cohesion.rice.edu/centersandinst/safa/emplibrary/AmejeSafa2008.pdf accessed 24 November 2009.

[44] Bargery, *A Hausa-English dictionary*, p. 1010.

Zube is dense black because the carbon particles can be ground extremely fine and uniform in size. Recipes for carbon black inks vary widely, as the ethnocultural recipes illustrate. The quality of the product is dependant upon the care and time taken in its preparation. These lampblack types of inks took much longer to prepare than basic *tawada*. With the addition of gum they produced a distinctive look, in many instances glossy and shiny from large quantities of gum added to the mix. This fine carbon could also be obtained from burning oils such as cottonseed, animal fat, ivory or the wood of the desert date, the result then ground to a fine powder. Basic *zube* could be made even glossier with the addition of honey or sugar or date pulp, which acts as a plasticizer and contributes additional smoothness, allowing the ink to flow even more easily from the reed pen. Egg white or egg yolk could also have been added to improve the binding properties and stability of the mixture. These additives to *zube* enabled the creation of regular, controlled calligraphy when using a reed pen with a broad nib.

The use of *zube* appears to have been confined to fine calligraphic *Qurʾāns* from Kano and particularly Bornu. These are the *Qurʾāns* held by the British Library or the Boston Museum of Fine Arts. Bornu was a center of Islamic culture since the 15th century and remained vital as a major center for Qurʾānic studies, calligraphic excellence and as a source of fine manuscript *Qurʾāns* even into the 20th century.[45] Without wanting to be overly deterministic, it is possible to consider that the limitations and essential properties of these *zube* inks may have contributed to the aesthetic features in these widely admired Bornu *Qurʾāns*—hard edged and opaque—which are particularly suited to the favored distinctive local script related to that used in North Africa. Lampblack ink takes a long time to prepare and a long time to dry; a day for one page of text, which might have taken two or three hours to write.[46] These are not the creations of peripatetic scholars but rather the product of sedentary *malams* with a fine, regular hand. These decorated *zube Qurʾāns* would have been created for the elite. *Zube*'s dense, hard-edged beauty is offset by its vulnerability. Even with great lashings of gum, *zube* is highly water-soluble.

The gum used in ink, *k'aro* in Hausa, *tuutam poolel* in Fulfulde, can be completely soluble in liquid up to its own volume. In order to reproduce the 'look' of Northern Nigerian inks, replicative experiments indicate that the volume of gum used should be near equal or equal to the volume of liquid. Gum is very important because when added to charcoal or soot, it improves the binding

[45] M. Hiskett, *The development of Islam in West Africa*. London, Longman, 1984, pp. 65-67.
[46] M.P. Brown, *Lion Companion to Christian art*. Oxford, Lion, 2008, p. 64.

properties and stability of the mixture. It acts as a binder and as an adhesive, giving ink the capacity to stick to the writing surface. It also plays a crucial role in maintaining the equal dispersion of the pigment particles in water until the ink has dried and the colors are gummed in place on the paper. Recent research has also illustrated the inhibiting factors of gum on ink corrosion.[47] It is undoubtedly due to the profusion of gum that ink corrosion is relatively uncommon in these manuscripts. In addition to the *Acacia* gums there are others such as *karaya* gum (BL59), which is tragacanth-like and has been also been used in Northern Nigeria as a dyeing mordant and by blacksmiths in tempering steel. These tragacanth-like gums produce mucilage rather than a solution. Tragacanth gums appear to be favored in Bornu and Adamawa, probably due to the high sheen they produce in ink. But no matter which gum source, the *malam* would have controlled glossiness and stability by the quantity and quality of gum added to the mixture, and for this he would have been dependent on the gum collectors and gum merchants.

Wanke is the ink most widely encountered in Northern Nigerian manuscripts. Made from soot collected from the bottom of cooking pots, it was boiled or steeped in hot water. This dye water could then be filtered, or decanted, a simple process whereby particulates are put in suspension in water, stirred or shaken vigorously and left to settle, allowing the coarsest particles to sink to the bottom. The colored water, sometimes with particulates, would then be drawn off. Depending upon the wood burned, the color of the water, which is a dye, can vary from light yellow to dark golden brown, will be transparent and might have some particulate residue. This ink produces a marked modulation in tone from dark to light within the same stroke. To intensify the color a *malam* could use tannins and mordants such as *gabarawa* pods (BL28), supplies and knowledge obtained from the tanner and the dyer.

Inks, Charms and Medicine

In generalities are concealed the details of the art. Knowledge has its price and conditions, and some practitioners would be more willing than others to reveal their treasured secrets, particularly in exchange for good health. In 19th century Northern Nigeria, an era of vicious annual military campaigns, European travelers Denham, Clapperton, Barth and Nachtigal recorded an obsession with charms. Courtiers sought charms 'against balls or arrows' to be strung

[47] C. Remazeilles, et al., 'Influence of gum Arabic'.

together and hung around the necks of their horses and themselves. Denham also recounted a story of 'an old Hadgi' who cured a sick woman by writing charms—sentences from the *Qur'ān*—on a new wooden bowl. He washed the ink off the bowl, the woman drank the inky water and was cured.[48]

There is a psycho-sensual dynamic that lies at the heart of how charms and talismans, as spiritual utensils, function. The reality of these objects are not just artifacts but are also perceived by the participants as living, interactive energy sources destined to embody and radiate spiritual blessings. It should not be forgotten that ritual life is a reflection of everyday life and in many areas and in many places the two coincide. Northern Nigerian Islamic charms, regardless of their outward form or intended purpose, are composed of writing and squares. The elaborate pictorial elements of charms from Guinea, Senegal and Sierra Leone, described by Bravmann[49] are not present. Instead, there is an icon-like symmetry in the squares. The squares are geometrical devices demonstrating the perfection of the universe, and are included to reassure and provide mystical protection. The squares are often third, fourth or even fifth order mathematical magic squares, where the sum of the integers in each row, each column and each main diagonal are equal to the same sum. The calligraphy represents the word of God. The word was dominant but the word and the squares are of ink that could also be a medicine with paper the delivery tool.

Ninety percent of the Northern Nigerian plants with ink potential also have medicinal properties (Appendix 1, Table 1). Traditional Hausa medicine presupposes that the ingredients of successful medicines are found in the trees, shrubs, plants and animals created by God, his *Qur'ān*, and the traditions of the Prophet.[50] The possibility that some *malams* may have used ink as a way to deliver medicine would not have been a unique practice. As early as the 10th century AD the Chinese commonly used ink in medicine.[51] An internet search on any one of the sixty-three botanical ingredients listed in Appendix 1 results in hundreds of links to medical studies but even so our knowledge of African plant chemistry appears to be far from complete. Archaeologists well know the importance of context. Two private manuscript collections, one in Katsina

---

[48] D. Denham, et al., *Narrative of travels and discoveries in central Africa*, Denham's narrative pp. 79, 104, 203.

[49] R. Bravmann, *Islam and tribal art in West Africa*. Cambridge, Cambridge University Press, 1974; R. Bravmann, *African Islam*. Washington, D.C., Smithsonian Institution Press, 1983.

[50] L.L. Wall, *Hausa medicine. Illness and well-being in a West African culture*. Durham, Duke University Press, 1988, pp. 288-289.

[51] T. Tsuen-Hsuin and J. Needham, S*cience and civilization in China.* Vol. 5, *Chemistry and chemical technology*, Part 1: *Paper and printing*. Cambridge, Cambridge University Press, 1985, p. 247.

and one in Yola were boxed on their owners demise some decades ago. When these collections were unpacked in 2008 manuscript charm exemplars were found tucked into charts of herbal remedies. The multigenerational family manuscript collection of Modibbo Fufore, now at Arewa House Kaduna, contains several accessible examples though the context has now been lost through collection rearrangement.

When a person was ill and home remedies did not suffice people sought medical help from *malams*, who would inscribe a Qur'anic verse within a prayerful fortress of magic squares.[52] The 'charm' would be copied onto paper using information contained in herbal manuals passed down through individual families. The supplicant, the patient, would be instructed to soak the paper in water rinsing off the ink. It was then to be drunk or used as a body wash, thus counteracting malevolent forces with the infinite powers of the word of God. These processes could have had efficacy beyond the psychological in the medicinal properties that the ink might contain. And as such, a charm would be a remarkable device for healing and far more complex than the word charm implies. Additionally, the ink itself could have a psychological impact as it changed dimension. Consider the impact of having ink expand many times its original size when rinsed off paper. When wetted glossy *karaya* gum (BL59) can expand dramatically.

In the patient's view, by drinking the ink from the paper they ingested the words of God, ingesting holy prayers and protective formulae—the ultimate medicine, for who is more powerful than God? In this context words were not just abstract concepts but a reality that could be absorbed as medicine to eradicate illness or improve wellbeing. Patients do seek out those whose medicine is perceived to be efficacious and look to past records of accomplishments. These charms of ink and paper, appealed to both supernatural and natural worlds. Prayers and amulets came directly from God. They contained His words. But in addition they contained secular knowledge. There is considerable literature in Arabic manuscripts demonstrating secular knowledge of inoculation against smallpox, treatment of wounds, guinea-worm, and medical plants, centuries older than that known in the West.[53] This knowledge would have been added to the specialized and esoteric knowledge of the advanced scholar, which was protected by the value placed on the manuscript books from which the scholars derived their knowledge. These manuscripts were inherited as patrimony, keeping such secret knowledge within families.

---

[52] Skinner, *Alhaji Mahmudu Koki*, pp. 16-17; Wall, *Hausa medicine*, pp. 232-239.

[53] P.E. Pormann and E. Savage-Smith, *Medieval Islamic medicine*. Washington D.C., Georgetown University Press, 2007.

The selection of Qur'ānic verses for charm and amulet making would not have been arbitrary. The selection required special knowledge, including knowledge of medical plants, plants that could also be made into ink. Wrapping, enrapturing and promoting physical and psychological well-being through the medium of ink on paper.

Conclusion

Microscopic and chemical examination of the inks used in the Northern Nigerian manuscripts, ethnocultural ink recipes, replicative ink experiments, and botanical information reveal that ink fabrication in Northern Nigeria was dependant on a complicated interdependency and web of access to particular resources, craft skills and knowledge. Nomadic pastoralists would migrate to distant pastures during the wet season to take advantage of ephemeral sources of water and rich pasture. This exposed herdsman to vast stretches of land rich in desirable minerals and plant resources of potential use in *malam*s' inks and pigments. The iron smelter produced a by-product of little use to him—slag—but of vital importance to the *malam*. The dyer produced a red dye, *karan dafii*, from common guinea corn that the *malam* could use for rubrication or for modifying another ink. The smelter and the dyers needed traders for raw materials, some of which, turmeric for example, would, by the 18th and 19th century, be coming from the south. The agriculturalist grew calabash needed as ink pots, the charcoal burner fabricated charcoal for the most basic of inks, and the non-Muslim brewed *kanga*, a fermented alcoholic drink. Everyone needed to eat and soot, the by-product of cooking—which was practiced only by women—was the foundation for the ink most widely encountered in the manuscript books of Northern Nigeria.

The diversity of inks and pigments used in the manuscript books of Northern Nigeria documents unpredictable access to supplies and development of complex replacement strategies utilizing deep knowledge of the land and its botanical resources, knowledge that was part of each community's lore. What ink was used was determined by what materials and knowledge were available at the time a particular manuscript was written, coupled with the desired outcome. The inks reveal a web of access, obligations and rights. The interrelationships between *malams*, traders, pastoralists, agriculturalists and craft specialists display symbiosis but one that would become increasingly asymmetrical under the impact of European incursions. The wide range of ink variations is indicative of positive responses to variable resource and climatic conditions

and to the uncertain availability of raw materials. Some of these variations are more than just adaptations; some are distinct technological modifications, indigenous developments reflecting skillful resource manipulation.

Making inks for a manuscript book required the industry of various practitioners come together. Raw materials must be obtained and processed, often by painstakingly time-consuming and even dangerous methods since several botanical ingredients are caustic or poisonous (for example BL12 and BL21). These technologies required extensive knowledge and skill. Implements—pens, brushes and a variety of tools—must be made. Processes, from the grinding of pigments to the selection and mixing of ink ingredients, were learned and transmitted from teacher to pupil. West African history and culture have been shaped by its context. Whilst it has been at times heavily influenced by the outside world, West Africans themselves, particularly those in the *sudano-sahel*, have resiliently solved the problems they faced and have come up with their own solutions to those problems. No matter the circumstance these practitioners made the most of their environment to produce their manuscript books of ink on paper.

Appendix 1

Botanical List (BL) of Northern Nigerian plants with potential ink use

Latin botanical name	English name	Burkill 1985-2000
1. *Araliaceae Cussonia arborea*		I, 211-212
2. *Balanitaceae Balanites aegyptiaen*	soapberry or thorn tree (dried fruit—desert date)	I, 242-246
3. *Bixaceae Bixa orellana*	annato	I, 269
4. *Boraginaceae Arnebia hispidissima*		I, 285
5. *Burseraceae Boswellia dalzielii*	frankincense tree	I, 300-301
6. *Cochlospermaceae Cochlospermum planchonii*		I, 386-387
7. *Cochlospermaceae Cochlospermum tinctorium*		I, 387-388
8. *Combretaceae Anogeissus leiocarpus*	chewstick tree	I, 389-391
9. *Compositae Eclipta alba*	ink plant	I, 466-467
10. *Euphorbiaceae Alcornea cordifolia*	Christmas bush	II, 25-28
11. *Euphorbiaceae Bridelia ferrunginea*	locust bean tree	II,35-37
12. *Euphorbiaceae Euphorbia hirta*	asthma herb	II, 70-71
13. *Euphorbiaceae Humenocardia acida*		II, 85-87
14. *Euphorbiaceae Jatropha curcas*	physic nut	II, 88-90

(*cont.*)

Latin botanical name	English name	Burkill 1985-2000
15. *Gramineae Pennisetum glaucum*	bullrush millet	II, 313-317
16. *Gramineae Sorghum arundinaceum*	Kamerun grass	II, 347-348
17. *Gramineae Sorghum bicolor*	guinea corn	II, 348-355
18. *Iridaceae Crocus sativus*	saffron crocus	II, 423-424
19. *Leguminosae: Caesalpinioideae Burkea Africana*		III, 70-72
20. *Leguminosae: Caesalpinioideae Caesalpinia bonduc*	false sappanwood	III, 73-74
21. *Leguminosae: Caesalpinioideae Erythrophleum suaveolens*	red water tree	III, 116-120
22. *Leguminosae: Caesalpinioideae Haematoxylon campechianum*	logwood	III, 130-131
23. *Leguminosae: Caesalpinioideae Piliostigma reticulatum*	Camel's foot	III, 144-146
24. *Leguminosae: Caesalpinioideae Piliostigma thonningi*	Camel's foot	III, 146-150
25. *Leguminosae: Caesalpinioideae Senna obtusifoli*	foetid cassia	III, 157-160
26. *Leguminosae: Caesalpinioideae Tamarindus indica*	tamarind	III, 169-176
27. *Leguminosae: Mimosoideae Acacia farnesiana*	sweet acacia	III, 180-181
28. *Leguminosae: Mimosoideae Acacia nilotica*	Egyptian mimosa	III, 186-190
29. *Leguminosae: Mimosoideae Acacia polyacantha*	catechu tree	III, 191-192
30. *Leguminosae: Mimosoideae Acacia senegal*	gum-arabic tree	III, 192-196
31. *Leguminosae: Mimosoideae Acacia seyal*	white galled acacia	III, 196-199
32. *Leguminosae: Mimosoideae Acacia sieberiana*	white thorn	III, 199-201
33. *Leguminosae: Mimosoideae Parkia biglobosa*	African locust tree	III, 245-251
34. *Leguminosae: Mimosoideae Prosopis Africana*	ironwood	III, 258-292
35. *Leguminosae: Mimosoideae Baphia nitida*	camwood	III, 292-294
36. *Leguminosae: Papilionoideae Indigofera*	indigo	III, 361-383
37. *Leguminosae: Papilionoideae Mucuna sloanei*	horse-eye bean	III, 409
38. *Leguminosae: Papilionoideae Pterocarpus erinaceus*	African rosewood	III, 427-429
39. *'Liliaceae' (Alliaceae) Allium cepa*	onion	III, 488-489
40. *Lythraceae Lawsonia inermis*	henna	III, 562-564
41. *Lythraceae Punica granatum*	pomegranate	III, 564-565
42. *Malvaceae Gossypium*	cotton	IV, 17-21
43. *Malvaceae Gossypium arboreum*	tree cotton	IV, 22-23
44. *Meliaceae Pseudocedrela kotschyi*	cedar-mahogany	IV, 117-119

(*cont.*)

Latin botanical name	English name	Burkill 1985-2000
45. Moraceae Fiscus platyphylla	Kano rubber tree	IV, 188-190
46. Myrtaceae Eugenia caryophyllus	clove	IV, 245
47. Myrtaceae Psidium guajava	guava	IV, 251-252
48. Olacaceae Ximenia Americana	wild lime	IV, 294-297
49. Palmae Borassus aethiopum	desert palm	IV, 341-347
50. Palmae Hyphaene thebaica	doum palm	IV, 371-373
51. Periplocaceae Cryptolepis sanguinolenta		IV, 425
52. Rubiaceae Gardenia erubescens	gardenia	IV, 538-539
53. Rubiaceae Gardenia ternifolia	gardenia	IV, 541-544
54. Rubiaceae Rothmannia longiflora		IV, 606-607
55. Rutaceae Citrus aurantifolia	lime	IV, 641-643
56. Scrophulariaceae Striga hermonthica	witchweed	V, 84-85
57. Scrophulariaceae Striga macrantha	witchweed	V, 85
58. Sterculiaceae Cola acuminata	kola	V, 141-143
59. Sterculiaceae Sterculia setigera	*karaya* gum tree	V, 171-173
60. Sterculiaceae Sterculia tragancantha	African tragancanth	V, 173-174
61. Tamaricaceae Tammarix senegalensis	tamarisk	V, 184-185
62. Verbenaceae Vitex doniana	black plum	V, 272-275
63. Zingiberaceae Curcuma domestica	turmeric	V, 317-318

There are variant Hausa and Fulfude names for plants and trees. These two internet sites, whilst in draft form, are the most comprehensive to date: Roger Blench: *Hausa names for plants and trees* http://www.rogerblench.info/Ethnoscience%20data/Hausa%20plant%20names.pdf and Roger Blench: *Fulfulde names for plants and trees* http://www.scribd.com/doc/35788430/Fulfulde-Plant-Names are useful guides for the variable names and spellings.

Appendix 2

Table 1 Botanical Characteristics

Plant	*Dye*	*Ink*	*Tannin*	*Gum*	*Medicinal*	*Alcohol*
#1		1			1	
#2					1	1
#3	1				1	
#4	1					
#5		1			1	
#6	1				1	

Table 1 (*cont.*)

Plant	*Dye*	*Ink*	*Tannin*	*Gum*	*Medicinal*	*Alcohol*
#7	1				1	
#8		1	1	1	1	
#9	1	1			1	
#10	1		1		1	
#11			1	1	1	
#12			1		1	1
#13	1		1		1	
#14			1		1	
#15	1				1	
#16	1					
#17	1	1				
#18	1					
#19			1		1	
#20	1				1	
#21	1		1		1	
#22	1	1			1	1
#23	1		1		1	
#24	1		1		1	
#25	1				1	
#26	1		1		1	
#27	1	1	1	1	1	
#28	1	1	1	1	1	
#29		1		1	1	
#30		1		1	1	
#31	1	1	1	1	1	
#32		1	1	1	1	
#33			1		1	
#34			1		1	
#35	1				1	
#36	1				1	
#37	1				1	
#38	1				1	
#39	1				1	
#40	1	1	1		1	1
#41	1	1	1		1	1
#42	1	1			1	

Table 1 (*cont.*)

Plant	*Dye*	*Ink*	*Tannin*	*Gum*	*Medicinal*	*Alcohol*
#43	1	1			1	
#44	1		1		1	
#45	1		1		1	
#46	1				1	
#47	1		1		1	
#48		1	1		1	
#49	1				1	
#50	1				1	
#51	1				1	
#52	1				1	
#53	1				1	1
#54	1	1			1	
#55	1	1	1		1	
#56	1	1	1		1	
#57		1	1			
#58	1		1		1	
#59			1	1	1	
#60					1	1
#61			1			
#62	1	1			1	
#63	1				1	
TOTAL	45-71%	22-35%	29-46%	9-14%	57-90%	7-11%

Acknowledgements

Three 2008-2009 research tours under a United States Ambassadors Fund for Cultural Preservation Grant, U.S. State Department Speaker's Grant and the generosity of the Modibbo Fufore Family enabled me to analyze inks in several thousand manuscript pages in these Northern Nigerian collections:

Kaduna—National Archives of Nigeria; Arewe House Archives and Museum
Zaria—Kashim Ibrahim Library, Northern History Research Scheme, Ahmadu Bello University
Kano—Kano History and Cultural Bureau (Gidan Dan Hausa); Gidan Mikama Museum

Salame—Al-Torodi Collection (private)
Sokoto—Center for Islamic Studies, Usmanu Danfodiyo University; Waziri Junaidu History and Culture Bureau
Katsina—Katsina History and Culture Bureau (two private anonymous collections)
Maiduguri—Center for Trans-Saharan Studies, University of Maiduguri
Yola—Fombina Palace Museum (National Museum Yola); Modibbo Ahmadu Fufore and Modibbo Muhammadu Raji Collections
Jos—National Museum Jos, Collection of Arabic Manuscripts.

This work would have not been possible without the warm and generous support of the owners, custodians, staffs, directors, librarians, archivists, professors and administrators of these collections and institutions.

I would also like to thank Lecturer David Edwards—University of Leicester; Director Barbara Jones—American Library Association Office for Intellectual Freedom; Head Librarian Pat Tully and Provost Joe Bruno—Wesleyan University; Public Affairs Section of the U.S. Embassy in Abuja, Nigeria, and, in particular, Henry Mendelsohn; Arewa House Kaduna—Malam Musa Mohammed, Salisu Bela and Director Dr. Mahmoud Hamman; Alhaji Sa'adu Ahmed and the Fufore Family of Yola; Robert McKelvey and the Adelphic Education Fund; and Dr. David Biddle, my husband.

References

Alkali, H. 2002, *The chief arbiter: Wazir Junaidu and his intellectual contribution*, [Centre for Islamic Studies, Usman Danfodio University, Sokoto, Nigeria].
Ameje, J. 2008. Traditional iron working in parts of the 'Nok Culture' area: notes and posers from preliminary investigations [National Commission for Museums and Monuments Abuja, Nigeria] http://cohesion.rice.edu/centersandinst/safa/emplibrary/AmejeSafa2008.pdf accessed 24 November 2009.
Balfour-Paul, J. 1997, *Indigo in the Arab World* [Curzon Press Richmond].
Bargery, G.P. 1934, *A Hausa-English dictionary and a English-Hausa dictionary* [Oxford University Press Oxford].
Barth, H. 1857, *Travels and discoveries in north and central Africa… in the years 1849-1855* [Harper and Brothers New York].
Battcock, M. and S. Azam-Ali 1998, *Fermented fruits and vegetables: a global perspective* [Food and Agriculture Organization of the United Nations Rome].
Blair, S.S. 2006, *Islamic calligraphy* (Edinburgh University Press Edinburgh].
Bousfield, J. 1979, The world seen as a colour chart in *Classifications in their social context*, R.F. Ellen and D. Reason, eds. [Academic Press London] pp. 195-220.
Bovill, E.W. 1968, *Golden trade of the moors* [Oxford University Press New York].
Boyd, J. 1989, *The Caliph's Sister: Nana Asma'u 1793-1865 teacher, poet and Islamic leader* [Frank Cass London].

Bravmann, R. 1974, *Islam and tribal art in West Africa* [Cambridge University Press Cambridge].
Bravmann, R. 1983, *African Islam* [Smithsonian Institution Press Washington, D.C.].
Brockett, A. 1987, Aspects of the physical transmission of the Qur'an in 19th century Sudan: script, decoration, binding and paper, *Manuscripts of the Middle East* 2, pp. 45-67.
Brown, M.P. 2008, *Lion Companion to Christian art* [Lion Oxford].
Bulliet, R.W. 1975, *The camel and the wheel* [Harvard University Press Cambridge].
Burkill, H.M. 1985-2000, *Useful Plants of West Tropical Africa* [Royal Botanic Gardens Kew].
Carvalho, D.N. 1904, *Forty centuries of ink* [Banks Law Publishing Co. New York].
Chabbouh, I. 1995, 'Two new sources on the art of mixing ink' in Yasin Dutton (ed.), *The codicology of Islamic Manuscripts. Proceedings of the second conference of Al-Furqan Islamic Heritage Foundation 1993*, London, Al-Furqan Islamic Heritage Foundation, pp. 59-76.
Clarke, M. 2002, 'Limitations of fluorescence spectroscopy as a tool for non-destructive in situ identification of organic pigments, dyes and inks' in: R. Van Grieken, K. Janssens, L. Van't dack and G. Meersman (eds.), *Art 2002: 7th International Conference on Non-Destructive Testing and Microanalysis for the Diagnostics and Conservation of the Cultural and Environmental and Environmental Heritage, 2-6 June 2002*, Congress Centre Elzenfeld, Antwerp, Belgium: proceedings [University of Antwerp].
Connah, G. 1998, *Transformations in Africa: essays on Africa's later past* [Leicester University Press London].
Connah, G. 2001, *African Civilizations: an archaeological perspective* [Cambridge University Press Cambridge].
Denham, D., H. Clapperton and W. Oudney 1826, *Narrative of travels and discoveries in central Africa in the years 1822, 1823 and 1824* [John Murray London].
Eguchi, P.K. 1986, *An English-Fulfulde dictionary.* [Institute for the Study of Languages and Cultures of Asia and Africa Tokyo].
Gettens, R.J., R.L. Feller and W.T. Chase 1972, Vermillion and cinnabar, in: *Studies in Conservation* 17, pp. 45-69.
Gettens, R.J. and G.L. Stout 1966, *Painting materials: a short encyclopaedia* [Dover Publications New York 1942, 1966 reprint].
Gruber, C. ed. 2010, *The Islamic manuscript tradition: ten centuries of book arts in Indiana University collections* [Indiana University Press Bloomington 2010].
Hassan, S.E.M. 1988, *Lore of the traditional malam: material culture of literacy and ethnography of writing among the Hausa of Northern Nigeria* [University of Pennsylvania Philadelphia, PhD thesis].
Hastings, A.C.G. 1925, *Nigerian days* [John Lane London].
Hawks, C. 2010, www.ellencarrlee.wordpress.com/2009/01 accessed 1 April 2010.
Hiskett, M. 1957, 'Material relating to the state of learning among the Fulani before their Jihad', *Bulletin of the School of Oriental and African Studies* 19, pp. 550-578.
Hiskett, M. 1967, 'The Arab star-calendar and planetary system in Hausa verse', *Bulletin of the School of Oriental and African Studies* 30, pp. 158-176.
Hiskett, M. 1973, *Sword of truth: the life and times of the Shehu Usuman Dan Fodio* [Oxford University Press New York].
Hiskett, M. 1984, *The development of Islam in West Africa* [Longman London].
Hunwick, J.O., R. Abubakre, H. Bobboyi, R. Loimeier, S. Reichmuth, and M.S. Umar 1995, *Arabic Literature of Africa II The Writings of Central Sudanic Africa* [E.J. Brill Leiden].
Ibish, Y. and G. Atiyeh, (eds.) 1996, *The conservation and preservation of Islamic manuscripts: Proceedings of the third conference of the Al-Furqan Islamic Heritage Foundation 1995* [Al-Furqan Islamic Heritage Foundation London].
Jomoh, I.A. 2007, The art of Qur'anic penmanship and illumination among Muslim scholars in southwestern Nigeria in *Word of God, Art of Man: The Qur'an and its Creative Expressions—Selected Proceedings from the International Colloquium London, 2003* [Oxford University Press Oxford] pp. 175-189.

Kriger, C.E. 2006, *Cloth in West African History*, [Altimira Press Lanham MD].
Lamb, M.J. 1981, 'The Hausa tanners of Northern Nigeria', *The New Bookbinder* 1, pp. 58-62.
Last, M., 2007, The book in the Sokoto Caliphate, paper delivered at Arewa House Conference 7-8 March 2007.
Levtzion, N. 1973, *Ancient Ghana and Mali* [Methuen London].
Levtzion, N. and J.F.P. Hopkins 1981, *Corpus of early Arabic sources for West African history* [Cambridge University Press Cambridge].
Levey, M., M. Krek and H. Haddad 1956, 'Some notes on the chemical technology in an 11th century Arabic work on bookbinding', *Isis* 47, pp. 239-243.
Levey, M. 1962, Medieval Arabic Bookmaking and its relation to early chemistry and pharmacology, *Transactions of the American Philosophical Society*, New Series Volume 52, Part 4.
Lowry, G.D., Beach, M.C., Marefat, R. and Thackston, W.M. 1988, *An annotated and illustrated checklist of the Vever Collection* [Smithsonian Institution Washington, D.C.].
Lydon, G. 2004, Inkwells of the Sahara: reflections on the production of Islamic knowledge in *Bilad Shinqit* in *The transmission of learning in Islamic Africa*, ed. S.S. Reese [E.J. Brill Leiden] pp. 39-71.
Mabogunje, A. 1972, The land and peoples of West Africa in *History of West Africa*, Vol. 1, eds. J.F.A. Ajayi and M. Crowder [Columbia University Press New York] pp. 1-32.
Masonen, P. 1997, Trans-Saharan trade and the West African discovery of the Mediterranean world in *Ethnic encounter and cultural change: papers from the Third Nordic Conference on Middle Eastern Studies, 1995*, eds. M'hammed Sabour and Knut S Vikør [Nordic Society for Middle Eastern Studies Bergen] pp. 116-142.
Mauny, R. 1978, 'Trans-Saharan contacts and Iron Age in West Africa' in: *The Cambridge history of Africa*, Vol. 2, ed. J.D. Fage, [Cambridge University Press Cambridge] pp. 272-341.
Meek, C.K. 1971, *The northern tribes of Nigeria* [Frank Cass and Co. London 1925, 1971 reprint].
Nachtigal, G. 1980, *Sahara and Sudan II: Kawar, Bornu, Kanem, Borku and Ennedi*, A.G.B. Fisher and H.J. Fischer, transl. [C. Hurst and Co. London].
Nixon, S. 2009, Excavating Essouk-Tadmakka (Mali): new archaeological investigations of early Islamic trans-Saharan trade, *Azamia: Archaeological Research in Africa* 44, pp. 217-255.
Norris, H.T. 1972, *Saharan myth and saga* [Clarendon Press Oxford].
Norris, H.T. 1984, *Sufi mystics of the Niger Desert* [Clarendon Press Oxford].
Pedersen, J. 1984, *The Arabic book* [Princeton University Press Princeton, New Jersey].
Pormann, P.E. and E. Savage-Smith, 2007, *Medieval Islamic medicine* [Georgetown University Press Washington, D.C.].
Remazeilles, C., Rouchon-Quillet, V. and Bernard, J. 2004, 'Influence of gum Arabic on iron gall ink corrosion. Part 1: a laboratory samples study', in: *Restaurator* 25/4, pp. 220-232.
Safwat, N.E. 2000, *Qur'ans and other manuscripts from the collection of Ghassan I. Shaker* [Oxford University Press for Azimuth Editions Oxford].
Skinner, N. ed. 1977, *Alhaji Mahmudu Koki: Kano malam* [Ahmadu Bello University Press Zaria, Nigeria].
Skinner, N. 1996, *Hausa comparative dictionary* [Rüdiger Koppe Verlag Köln].
Spielman, A. and D'Antonio, M. 2001, *Mosquito: a natural history of our most persistent and deadly foe* [Hyperion Books New York].
Temple, O. 1967, *Notes on the tribes, provinces, emirates and states of the northern provinces of Nigeria* [Barnes and Noble New York 1922, 1967 reprint].
Thackston, W.M. 1990, 'Treatise on calligraphic inks: a disquisition on paper, colors, inks and pens by Simi of Nishapur' in: *Intellectual Studies on Islam: Essays written in honor of Martin B. Dickson* [University of Utah Press Salt Lake City, Utah].
Tsuen-Hsuin, T. and Needham, J. 1985, S*cience and civilization in China*, Vol. 5: *Chemistry and chemical technology*, Part 1: *Paper and printing* [Cambridge University Press Cambridge].
Wall, L.L. 1988, *Hausa medicine: illness and well-being in a West African culture* [Duke University Press Durham].