CONSERVATION OF THE GENETIC DIVERSITY OF NIGERIAN INDIGENOUS CHICKENS FOR FUTURE BREED DEVELOPMENT: BIOTECHNOLOGICAL ISSUES AND PROSPECTS

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Abstract

The issues associated with biotechnological approach to genetic diversity conservation of Nigerian indigenous chickens (NIC) in readiness for future breed development were reviewed. It was observed that NIC genetic diversity is relatively wide with unique traits that are peculiar to the Nigerian environment. Characterization of NIC as reported by some researchers is based on location, ecotype and plumage arrangement. Information gathered in the present study shows that conscious selective breeding, natural catastrophes, unstable policies from public and private sectors, limited funds for the establishment of biotechnological conservation centres, and inadequacy of skilled manpower are a major set-back to the molecular characterization and biotechnological approach for effective improvement and genetic conservation of desirable traits in NIC rather than by the conventional pure breeding, crossbreeding and artificial genetic selection techniques. It was found that there are obvious numerous constraints to be overcome if biotechnologies are to make a significant positive contribution to the conservation of desirable traits in NIC. When these challenges are overcome, especially through the application of genomics and molecular DNA marker research, the danger of extinction and fear of genetic erosion of the NIC's rare genes will be maximally reduced.

Keywords: genetic diversity, Nigerian indigenous chickens, conservation, molecular marker, conventional breeding

Introduction

Nigerian Indigenous Chickens (NIC) constitutes about 80 percent of the 166 million poultry birds in Nigeria (FAO, 2007). Indigenous chickens are those chickens that belong to an area where they have evolved; they are also called native or local chickens. FAO (2001) and Adene (2004) reported that indigenous chicken exhibit large variation in body size, plumage colours, feathering pattern, eggshell, earlobe and shank colour. NIC represent valuable resources for livestock development because of their extensive genetic diversity, which allows for the rearing of poultry under varied environmental conditions. Their meat and eggs are preferred widely by consumers because of their taste, leanness, and suitability for special dishes (Horst, 1989). These qualities have made NIC attractive in the context of poverty alleviation and protein supply (Orheruata *et al*., 2006). Recent studies, relating to the development of the NIC as a potential layers have shown appreciable improvement in egg production traits of

NIC under intensive management system (Omeje and Nwosu, 1988; Adebambo, 2005; Momoh *et al.,* 2007; Peters *et al.,* 2007; Adeolu and Oleforuh-Okoleh, 2011 and Oleforuh-Okoleh *et al.,* 2012). Despite these functions, little is known about NIC genetic diversity.

Biodiversity can be described at several levels, ranging from phenotypic observation to molecular data. Bio-diverse systems are usually more sustainable than monocultures, and biodiversity often harbours genetics resources that, although underused today, but in the future may contribute to economic and social development (FAO, 2007). The NIC genetic diversity is relatively wide, since there has been little intensive breeding for narrow production objectives with consequent loss of genetic materials. The diversity in agro-ecology, climatic conditions and rearing of NIC rearing in different ecological zones of Nigeria are believed to contribute to the current high diversity in NIC genetic resources. Nevertheless, an increasing loss of genetic diversity has been observed for all agriculturally used species, and more than half of common livestock breeds especially poultry are now endangered or at risk of extinction (Dohner, 2001; Hoffmann, 2005). There is a general consensus (Sere and Steinfeld, 1996) that introducing high yielding livestock breed into traditional and extensive production systems can lead to loss of genetic diversity in indigenous animals. This may be due to genome dilution of "local hybrid" through crossbreeding during and after such programme. The fast growth of global chicken commercialization, together with the advent of highly pathogenic avian influenza, H5NI virus, have also been identified (Hoffmann, 2009) as one of the factors that have increased the population of local chicken to be under the threat of extinction.. Thus, a combined adoption of systematic identification, inventory and description of the NIC ecotypes and management systems would be imperative understanding, conserving and manipulating the biodiversity of the NIC's genetic resources not only for their current use but also for future breeding and productive purposes.

The objective of this paper was to examine the constraints associated with biotechnological approach in genetic diversity conservation of NIC and future prospects and utilization of such approach and conservation.

Phenotypic Characterization of Nigeria Indigenous Chickens (NIC)

FAO (2004) described characterization as a clear definition of the genetic attributes of an animal species or breed, which has a unique identity and the environment to which the species or breed populations are adapted. The genetic distinctiveness of an animal forms the basis for distinguishing it among different animal genetic resources and for assessing the available diversity.

Nigerian Indigenous Chickens (NIC) has not been characterized properly in different ecological zone. Information about their genetic resource is meagre. However, there have been some efforts at characterizing the NIC. These efforts include classification based on location; for example, Sonaiya and Olori (1992) noted two ecotypes characterized as forest and savannah (Yoruba) and Fulani ecotypes respectively. Nwosu (1979) reported three main strains in ecotypes, named, Nsukka, Owerri and Awgu types in the South East of Nigeria. Recent studies (Fayeye *et al.,* 2005 and Momoh *et al.,* 2007) revealed that the different ecotypes can be grouped into two major categories on the basis of body size and body weight as heavy ecotype and light ecotype. The heavy ecotype is found in the dry savannahs (Guinea and Sahel Savannah), mountain region and cattle kraals of the North and weigh about 0.9 – 2.5kg at maturity (Fayeye *et al.,* 2008). The light ecotypes are those chicken types from the Swamp Rainforest and

Derived Savannah agro – ecological zones whose mature body weight ranges between 0.68-1.5kg (Momoh and Nwosu, 2008). NIC has also been characterized along genetic lines of feather and plumage colour - such as normal or frizzled (Ibe, 1993; Ebozoje and Ikeobi, 1995 and Peters *et al.,* 2007), body structure - such as naked neck, dwarf types (Ohwojakpor *et al.,* 2012) and colour variants – such as black, white brown, mottled among others (Adebambo, 2005).

The fizzle gene(f) is mutant in chickens (Ohwojakpor *et al.*,2012) and is responsible for the modified plumage conditions arising from the curving of the rachis of all feathers with curling of the barbs, in which the feathers grow so that they curve outward, instead of lying smoothly along the birds body. Yakubu *et al.* (2008) described naked neck gene as incompletely dominant with Na/na birds showing an isolated tuft of feathers on the ventral side of the neck above the crop, while Na/Na birds either lack this tuft or it is reduced to just a few pin feathers or small feathers. The resulting bare skin becomes reddish, particularly in males as they approach sexual maturity (Somes, 1990). The reduction in feather coverage in naked neck birds permits conventional heat loss from the animal surface, thereby leading to improved thermo-regulation under the prevailing conditions. Normal feather (na/na) is the most common type, it is neither fizzles nor featherless.

Mohammed *et al*. (2008) reported the superiority of bare – neck indigenous Sudanese chickens over two other local ones in terms of live weight. Similarly, Merat (1990) reported that in high temperature near 30 ^{0}C or higher, naked – neck birds had a better laying rate, mean egg weight, egg shell strength and carcass yield than normal feathered birds.

Table 1: Percentage Feather Distribution of NIC from Different States of Nigeria.

	Feather types distribution (%)			
States	Normal (na/na)	Frizzed (ff)	Naked neck Na/Na or Na/na	Source
Edo	73.00	18.00	9.00	Orheruata *et al.* (2006)
8 States of South western Nigeria	75.60	7.37	12.16	Adebambo *et al.* (1999)
Bayelsa	91.80	5.20	3.00	Ajayi & Agaviezor (2009)
5 States of South-South region of Nigeria	43.75	33.75	22.50	Ohwojakpor *et al* .(2012)
Northern Region of Jos Plateau	96.40	7.90	3.60	Mancha *et al.(*2006)
Kaduna	86.69	1.82	5.00	Orunmuyi *et al. (*2010).

Figure 1. Normal feathered NIC cock

Figure 2. Frizzled feathered NIC cock

Figure 3. Naked Naked NIC cock

Source: Adeleke *et al.* (2011).

Molecular Characterization of NIC

Much has not been done on the molecular characterization of NIC. For proper characterization of principal livestock species for the purpose of conserving superior genotypes, it is advisable to use modern molecular marker technology such as microsatellites (SSR-Simple Sequence Repeats). This marker is capable of revealing all the genetic information inherent in any species population and can be used to measure important genetic diversity indices. Another molecular marker of importance is Mitochondrial DNA –CR marker (mtDNA – CR) or mtDNA D- loop. Adebambo *et al*. (2010) work on the characterization of the Nigerian village chicken using Mitochondrial DNA D- loop sequence revealed that there were no significant differences in genetic distance of indigenous chicken from three populations (South-west, North-west and North-east ecological zones) of Nigeria. But Adeleke *et al*. (2011) and Ohwojakpor *et al.* (2012) reported significant difference in genetic distant between both frizzle and normal – feathered chickens from naked neck chicken.

Other polymorphic DNA markers that can be used in molecular characterization of NIC are summarized in Table 2. Among the several DNA – based methods available, microsatellite markers provide the best and most reliable results when used with plants and animals (Wimmers *et al.,* 2000; Van Martle – koster and Casey, 2001; Olowofeso *et al.,* 2005; Ohwojakpor *et al*., 2012). Recent information in literature has revealed that microsatellite markers are useful in determining heterozygosity and estimating genetic distances among closely related species (Chen *et al.*, 2004).

Factors that Pre-dispose Nigerian Indigenous Chicken to Extinction.

NIC are becoming seriously endangered owing to the high rate of genetic erosion resulting from some factors that placed them in the red list of Intentional Union for the Conservation of Nature and Natural Resources (IUCN) - such situation include:

- Conscious selective breeding of Nigerians, who preferred smooth (normal) feathered chicken at the expenses of frizzled and naked-neck for aesthetic reasons and selection of few available frizzled and naked neck for socio-religious activities;
- Natural catastrophes; for example flooding, disease outbreak (avian influenza, H5N1), earthquake etc ;
- Unstable policies from public and private sectors. This may include non continuity in cockerel exchange programmes. NIC genetic resources may have been diluted due to foreign/exotic germplasm use during such programme;

- Limited funds for biotechnological conservation activities like modern molecular markers (e.g. Microsatellites, RFLP, SNP, AFLP etc)
- Limited availability of standard biotechnology research laboratory/centre in Nigeria – where available there is a market constraint for the purchase of markers, primers and other necessary equipment and reagents.

Inadequate qualified/skilled manpower to drive the processes involved in bio-techniques of NIC conservation

Table 2: Common DNA markers that can be used in molecular characterization of NIC.

DNA Marker	Brief Description	References
Restriction Fragment Length Polymorphisms (RFLPs)	This is a method that utilizes restriction enzymes to cut the DNA in the number and position of sites	Montaldo and Meza-Herrera (2010) Drinkwater and Hetzel (1991)
Single Nucleotide polymorphisms (SNPs)	The marker allows the capture of a greater part of the whole genomic variation and to achieve an assessment of the complete genetic variation	Eltanany and Distl (2010); Twito *et al*.(2007); chee *et al*. (1996)
Amplification fragment Length Polymorphisms (AFLPs)	DNA genetic marker used mainly in plant breeding but has potential use in poultry.	Chee *et al.* (1996); Montaldo and Meza-Herrera (2010)
Random Amplified Polymorphic DNAs (RAPDs)	This is a molecular based technique that involves the use of a single decamer or 10-mer random primer with isolated genomic DNA so as to generate PCR products. It is a simple and easy method to detect polymorphisms based on the amplification of random DNA segments with single primer of arbitrary nucleotide sequence	Olowofeso *et al*. (2005) Dubey (2006) Verma and Agarwal (2010)

Potential Utilizations of NIC for Future Breed Development.

According to FAO (2007), animal genetic diversity allows farmers to select stocks or develop new breeds in response to environmental change, threat of disease, new knowledge of human nutrition requirement, change in market conditions and societal needs. NIC represents valuable resources for poultry industry development because their extensive genetic diversity allows for rearing of poultry under varied environmental conditions, providing a range of products and functions. In fact, they represent a huge reservoir of chicken genome. Adeleke, *et al.* (2011) assured adequate World's food and global food security from proper utilization of appropriate animal genetic resources. Therefore, with biotechnological approach to NIC genetic resources conservation in Nigeria, future breed development of NIC with desirable traits (e.g.

disease-resistant breed, better feed conversion etc.) will be possible and as a result more hybrid "local chicken" will be available for human consumption. Their by- products will also provide necessary raw materials for emerging biotechnology companies-such as companies or organizations involved in production of feather meal from rejected feather and conversion of manure to organic fertilizer for crop production.

The frizzling and the naked genes in particular have been described as adaptability genes acting as sex marker and disease resistant factor (Islam and Nishibori, 2009). These genes cause a reduction in tropical heat stress by improving the breeds' ability for convention, resulting in improved feed conversion and better performance. Horst (1989) and Marthur and Horst (1999) showed that individuals with both "f" and "Na" genes or singly were superior to those with normal feathering for egg number, egg weight and other production traits in tropical environments. According to Ibe (1993), naked neck and frizzed genes are associated with earlier sexual maturity in a tropical environment. Therefore, NIC need to be maintained for the purpose of conserving the wide gene pool that they represent in the future, especially in this era of genomics and molecular DNA markers research.

Conclusion and Recommendations.

The present low frequency occurrence of some qualitative traits that could be used in future breed development calls for conservation programme in order to conserve and preserve these rare traits. Since NIC contain a repository of unexploited germplasm, genetic evaluation of the birds through an articulated and well planned improvement programme can serve as a great source of developing the poultry industry in Nigeria

It is also important that international organization like Food and Agriculture Organization (FAO), Intentional Union for the Conservation of Nature and Natural Resources (IUCN) and International Livestock Research Institute (ILRI) take the lead in developing standard approaches for identification, characterization and evaluation of NIC genetic reserve resources. Government on her part should enact policies and programmes that will entrench cutting-edge biotechnology research geared towards achieving these aspirations.

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