ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2016; 4(5): 20-23

www.fisheriesjournal.com
Received: 05-07-2016
Accepted: 06-08-2016

N Daniel
PhD Scholar, Fish Genetics and Biotechnology Division, ICAR-CIFE, Mumbai, India

Correspondence
N Daniel
PhD Scholar, Fish Genetics and Biotechnology Division, ICAR-CIFE, Mumbai, India

Neem seed cake (NSC) as fish feed ingredient: Opportunities and constraints

N Daniel

Abstract
With the increasing human population, fish will be cheapest protein food source which considerably contribute to human sector for the minimization of hunger and malnutrition. This situation to take place, it is essential to produce fish with minimum cost, so that it will reach poor people; need significant input from aquaculture. Feed accounts 50 to 60% of total expenditure in the aquaculture. The reduction of feed cost will improve the economic status of aquaculture business. At present, conventional ingredients utilised in fish feeds are costly, which increases the feed cost in turn raises the cost of fish for production. Therefore, it is a need for switch over to cost less non-conventional feed ingredients to produce fish with low costs and neem seed cake has great potential in this context. The scope and limitations to place NSC as one of the major ingredients during diet formulation was discussed in this technical review.

Keywords: Need seed cake, fish, feed, ingredient, aquaculture

Introduction
At present, the key issue which affected fish feed industry is the price rise of currently used feed ingredients [1]. Besides, lesser access and higher demand of conventional feedstuffs restrict their application for feed formulation. In fish production, about 50-60% of total operation cost is accounted by artificial feeds. Saving even small degree of costs for feed will definitely increase the profitability to fish farmers [2, 3].This constructs the temptation to feed formulators to look for cost less ingredient for fish diet preparation [4]. Preparing cost effective feed does not make sense if not nutritionally balanced. Therefore, the search for alternate unconventional feed ingredients which can replace conventional feedstuffs both nutritionally and economically got major attention among the feed manufacturers. Some researchers have motivated to identify those cost less ingredients. NSC is such an ingredient, which has great potential in these facets contain balanced nutrients [5].
Neem (*Azadirachta indica*) seed cake is a by-product of neem oil industry with a potential annual production of about 1 million tonnes. At present, it is largely used as manure-cum-insecticide and lesser extend used in animal feed industry [6]. It contains the high crude protein, amino acids and minerals profile, and does not spoil on storage or attack by fungi. The inclusion of NSC for animal feed was subjected to a major debate due to the presence of toxic and odour compounds and discouraged as its utilization affects animal health performances [7]. But the proper treatment can solve these problems. At present, research on terrestrial animals, including fish has shown that treated NSC is less or free of toxic and bad smell; therefore, it can be incorporated in the diet without affecting their growth and nutrient utilisation [8, 9]. But before reach the formulation stage, certain research need to be accomplished in the commercially important cultivable species with respect to this area. The percentage at which NSC can replace the other conventional feedstuffs should be properly addressed to the feed formulators.

Global scenario of world fisheries and aquaculture production
The present world fisheries and aquaculture state shows the importance of aquaculture to meet the protein demand of fish consumption. During 1960s global capture fisheries and aquaculture production was 33.9 and 1.6 million tonnes; and now it travelled to 93.4 and 73.8 million tonnes respectively [10, 11]. The statistics shows that global fish farming is on the top has a steep growth for last six decades and capture fisheries production had declining trend. Global

per capita fish consumption has increased over the past six decades, rising from 10 kg in 1961, 19 kg in 2012 [10] and now it reaches 20 kg [11]. According to statistics, every one third of fish consumed by human population is coming from farm raised. As recent years the human population increases, in order to avoid the competition for protein food and to avoid malnutrition cheapest source of fish food to humans must be easily available need intensive focus on aqua farming.

Conventional feed ingredients and its hampering effect to aquaculture

Expensive feeds for aquaculture affects the profitability of fish farmers [12]. High costs of conventional feed ingredients, especially fish meal and soybean affects the cost of production. In the last decade the price of the fish feed is significantly increased. If this situation continuous there will be a shortage of fish farmers to continue farming, which may results in the economic loss to fish feed industries. Feed accounts for 30-70% of total operation cost in fish farming [13] and no doubt that success in fish production is determined by the cost of feed. For instance, if greater part of production cost deals with feed, it will results to high production cost of farmed fish, which hampers the economic benefit of aquaculture development.

Why need replacement of conventional feed ingredients?

The conventional feed ingredients are costly. For instance, the price of fish meal in the market during 2007 was 21-33 Rs/Kg [14] and now it reaches 40-60 Rs/ Kg depending upon the availability and place. Similarly the cost of soybean meal during the year 2007 was 11.4-13.4 Rs/kg [14] and now it touched around 30-40 Rs/Kg. substituting them with non-conventional feedstuffs would fall in price of feed. Replacement of fishmeal and fish oil with available and cheaper plant feedstuffs has been identified as an essential requirement for the future development of aquaculture [15]. To replace fish meal, a nutritionally balanced Soya bean meal (SBM) is a common custom. SBM contains high protein and relatively well balanced amino acid profiles. It is limited and expensive source in fish feeds after fish meal [16]. As the cost for conventional protein sources including SBM is increasing [17] search to find out non- conventional, locally available, cheap feed ingredients as alternative energy source for fish feed is inevitable [5].

What hinders NSC usage in aqua feed?

Although NSC is nutritionally balanced the incorporation of NSC in animal diets was discouraged due to their adverse effect on their performance because of the presence of bitter and toxic Anti-nutritional factors of triterpenoids mainly nimbin, nimbidin, azadirachtin and salanin [18, 19]. The bitter taste of neem seed is as a result of the presence of sulphur containing compounds, while the tignic acid is the main compound believed to be responsible for its odour [7]. Meliacine forms bitter taste. Seed contain tignic acid (5-methyl-2-butanic acid) responsible for the distinctive odour of the oil [20]. Raw cake has revealed poor palatability and adverse performance. Poor palatability accompanied to the animals due to pungent smell and bitterness which lead to poor weight gain or loss of body weight along with lowered nutrient digestibility. Ruminants can tolerate higher levels of the NSC. However, monogastric animals can be tolerable to a lower limit.

Methods of processing and strategies to remove toxic and bitter compounds in NSC

First the kernel part of the neem is collected and it is sun dried. After ground dried the yield is only 50% out of 100%. Again it goes for removal of oil i.e. 20%. Finally, the rest 30% of de-oiled part is prepared as NSC by pellet pressing machine.

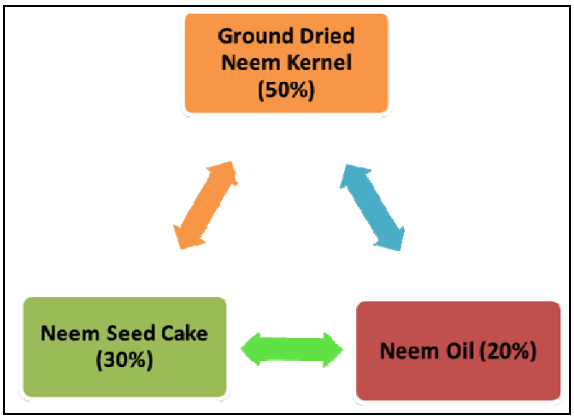

Fig 1: Production Cycle of Need seed Cake

Attempts have been made over the years to detoxify and reduce the bitterness of the NSC for animal use, through extraction, water washing, alkali soaking, urea ammunition and autoclaving [7-9]. In the market different kinds of neem seed cakes are available depending upon the method of processing and extraction of oil from neem seeds. Accordingly, these cakes also differ in their chemical composition and nutritive values. The major types of NSC such as expelled out neem seed cake (Decorticated and Undecorticated) and solvent extracted / deoiled NSC that are being manufactured from the industries of India.

Can the NSC substitute conventional feed ingredients in aqua feed?

The feed is profitable if it prepared economically and nutritionally balanced. Both economics and nutrition must play a pivotal role in the selection of feed ingredients. NSC is one of such source showing great potential for inclusion in animal feeds. NSC contains toxic and odour compounds which make it avoid using in the feed. But, when properly treated, NSC has high protein contents similar to that of soya bean. In addition, it is a good source of protein (45–50%), phosphorus, calcium and iron. A human need of these is very less and cost effective. As earlier mentioned, fish meal per kg is 40 to 60 Rs. and soybean meal per Kg is around 30 Rs. But, NSC is only around 10 to 15 Rs. per kg. Study of Cost and Benefit Analysis of experimental Diets with NSC as main ingredients were carried out in African catfish and co-authors [21] replaced with soybean meal in the diet. A result obtained in the study was represented in the table 1.

Table 1: Profit index of NSC based diet replaced with soybean meal in African catfish

Diets	Profit index	Cost/Kg/Feed(₦)
0% NSC	2.61±0.030	226.66
9.62% NSC	2.52±0.146	219.00
17.5% NSC	2.40±0.216	211.23
28.5% NSC	4.18±0.093	199.99
Commercial diet	1.16±0.021	450.00

Note: Price is in given in Nigerian dollars (₦) - Adapted from Hassan and co-authors [21]

Fish meal (60-80% CP) and Soya bean meal (40-55%) contains high protein and relatively well balanced amino acid profiles. So, it is very difficult to replace this in the fish diet. All over the globe, farmers are looking for alternative ingredients which can replace this without affecting the nutritional quality. Nutritional compositions of NSC have evaluated by many researchers and have been reported to be highly nutritious. Gowda and Sastry [6] stated that NSC is equal to Soybean protein contains 45–50% of CP, phosphorus, calcium and iron. The sulphur-containing amino acids content was high in the NSC. Lysine and methionine content higher than most of the cereal proteins but lower than that of legume proteins. Nutritional composition of NSC in comparison with other feed ingredients was represented in the table 2.

Table 2: Nutritional composition of NSC compared to other ingredients

Ingredients	Dry Matter	Crude Protein (CP)	Crude Fiber	Crude Lipid	Total Ash	Nitrogen Free Extract
Fish meal	88.70	60.00	0.00	10.56	9.22	20.10
Soybean meal	93.19	40.19	6.17	8.69	5.32	39.63
Neem seed Cake	89.88	31.81	8.06	5.11	8.26	46.76
Maize	90.73	10.00	2.70	4.00	1.30	82.00

Note: NSC also enriched with the following minerals; Calcium: 0.77%, Magnesium: 0.75%, Phosphorous: > 1%, Sulphur: 1.20%, Potassium: > 1%. Therefore, adding NSC in the diet may alleviate some mineral supplementation in the diet. Adapted from Hassan and co-authors [21]

Study of detoxified NSC in the diet of terrestrial animals

In terrestrial animals the study on detoxified NSC in the diet was explored and dosage at which NSC can be supplemented without affecting the animal performance has been standardized. Review of some selected research work in terrestrial animals is displayed in the table 3.

Table 3: Some selected studies on NSC in the diet of terrestrial animals

Animals	Remarks
Goats	Water washed NSC can be incorporated in diets up to 25% without deleterious effects on nutrient utilization and metabolism [22].
Lambs	Alkali treated NSC improved the crude protein digestibility and efficiency and body weight changes [23].
Crossbred calves	Water washed NSC can be feed without any adverse effect on their performance [24].
Pigs	Water washed NSC at 10-15% level in diet have no adverse effect on growth performance [25].
Buffalos	Alkali (2.5% W/W NaOH) treated and urea (3.5% W/W) ammoniated NSC could be fed at 30% level in the concentrate mixture had no any adverse effect on their performance and meat quality [26].
Cockerel Chickens	Water soaked NSC can replace part of soybean meal without any adverse effect on their performance [1].
Rats	Water washed NSC improved the reproductive maturity in rats but there was no adverse effect on semen quality of breeding bulls, quiet for long durations [27].

Attempted study of detoxified neem Seed Cake in the diet of aquatic animals

Despite the use of NSC for feeding explored very long ago in terrestrial animals, it was only three study conducted in the fish with response to use NSC as an ingredient. Till 2005, there was only one study was accessible on the use of NSC in fish feed [16]. However, after that there were two more supporting evidence became available for using NSC in the diet of aquatic animals [21, 28]. The results of these three conducted studies were displayed in the table 4.

Table 4: Some selected studies on NSC in the diet of aquatic animals

Animals	Remarks
Common carp (*Cyprinus carpio*)	The study discloses that water washed NSC at the level of 5% can be incorporated in the diet without affecting the animal growth and nutrient utilisation [16].
Common carp (*Cyprinus carpio*)	The study shoes that water washed NSC at the level of 15% in the diet did not affect the amylase and protease enzyme activity [28].
African catfish (*Clarias gariepinus*)	The result reveals that water washed NSC at the level of 25% in the diet can be incorporated without compromising fish growth and nutrient utilization [21].

Justifications to place NSC as one of the main ingredient in aquaculture

- Treatment can alleviate the odour and toxicity of NSC.
- Treated NSC is equal to Soybean meal.
- Treated NSC has no problems in palatability. Only exceeding dosage limits pose problems.
- Limiting amino acids in fish meal & soybean are rich in this.
- Easily available through the year and very less expensive as its annual production is around one million ton.
- Can be stored for a long time and does not attack by fungi.
- Human demand for NSC is very less and lesser competition with livestock.

Future expectations

So far research attempted on the assessment of NSC in fish diet was only conducted under wet laboratory conditions. This must be tried at farm levels also. The nutritional value of NSC varies according to the regions and therefore the composition of nutrients and anti-nutritional factors of raw and treated NSC from different regions has to be assessed. The nutrient utilization of fish fed with NSC based diets has to be studied and the inclusion levels in the fish diet have to be standardized without compromising any negative impacts to fish. This should be studied with commercially cultivable species. If there is any synergistic effect of NSC with other ingredients in the diet need to be studied. Their negative impact if any

noticed has to be investigated clearly. If there is any adverse effect to the animals should be properly addressed. If all these expectations fulfilled, the feed formulators can able to produce the feed cost effectively by placing NSC as a major ingredient. Simultaneously, feed cost can be significantly reduced for the sustainability of poor farmers for aquaculture.

Conflict of interest statement

Author declares that there is no conflict of interest in the manuscript.

Acknowledgement

Author thank to the Director, ICAR-CIFE for the facility given for preparing the manuscript.

References

1. Odunsi AA, Adegbile SA, Akande TO, Olayeni TB. Neem (*Azadirachta indica*) seed cake in the diets of cockerel chickens, International Journal of Poultry Science. 2009; 8(1):47-51.
2. Adesope MO. Attitudes of household in a Niger Delta Zone towards snail meat consumption. In: Ukachukwu, S.N. *et al*. (Eds.). Animal production in the new millennium: Challenges and Options. NSAP Secretariat. Zaria. 2000.
3. Ebenebe CI. Mini livestock production in nigeria. The present and future. Proceedings of 5th Annual Conference of Animal Science Association of Nigeria, 2000.
4. Siddhuraju P, Becker K. Preliminary nutritional evaluation of mucuna seed meal (*Mucuna pruriens* var. *utilis*) in common carp (*Cyprinus carpio* L.): An assessment by growth performance and feed utilization. Aquaculture. 2001; 196:105-123.
5. Bichi AH, Ahmad MK. Growth performance and nutrient utilization of African catfish (*Clarias gariepinus*) fed varying dietary levels of processed cassava leaves. Bayero Journal of Pure and Applied Sciences. 2010; 3(1):118-122.
6. Gowda SK, Sastry VRB. Neem (*Azadirachta indica*) seed cake in animal feeding scope and limitation. Asian-Austrelian Journal of Animal Science. 2000; 13:5.
7. Gowda SK, Sastry VRB, Katiyar RC. Study on the utilization of neem kernel meal as a protein supplement for growing rabbits. Indian Vetrenary Journal. 1998; 75: 281-282.
8. Bawa GS, Orunmuyi M, Agbaji AS, Landam Z, Okekeifi UO. Effect of different methods of processing neem (*Azadirachta indica*) seeds on performance of young Rabbits. Pakistan Journal of Nutrition. 2007; 6(3):213-216.
9. Uko OJ, Kamalu TN. Protein quality and toxicity of full-fat neem (*Azadirachta indica A. Juss*) seed kernel. Archieved Zootechnology, 2006; 55:51-62.
10. FAO. The state of world fisheries and aquaculture. Report of the fisheries and aquaculture department, Rome Italy, 2014.
11. FAO. The state of world fisheries and aquaculture. Report of the fisheries and aquaculture department, Rome Italy, 2016.
12. Adikwu. Dietary carbohydrate utilization in tilapia (*Oreochromis niloticus*), Journal of Agricultural Science Technology. 1992; 2(1): 33-37.
13. El-Sayed AM, Wainman LIE, Santangelo M, Unelius CR, Trimble RM. Relative attractiveness of (10E)-dodecen-1-yl acetate and (4E,10E)- dodecadien-1-yl acetate to male spotted tentiform leaf miners (Lepidoptera: Gracillariidae). Journal of Chemical Ecology. 2004; 30:1809-1820.
14. Suresh AV. Development of the aquafeed industry in India. FAO Fisheries Technical Paper, 2007; 497:221.
15. Tacon AGJ, Hasan MR, Subasinghe RP. Use of fishery resources as feed inputs for aquaculture development: Trends and policy implications. Food and Agriculture Orgnisation Fisheries Circular, 2006; 10(18):99.
16. Smita L, Shiba SG, Kumar PH. Performance of *Cyprinus carpio* (*var. communis*) fingerlings fed on diets containing water washed neem (*Azadirachta indica*) seed cake. Conference on International Agricultural Research for Development Stuttgar nheim, October, 2005, 11-13.
17. Siddhuraju P, Becker K. Preliminary nutritional evaluation of mucuna seed meal (*Mucuna pruriens* var. *utilis*) in common carp (*Cyprinus carpio* L.): An assessment by growth performance and feed utilization. *Aquaculture,* 2001; 196:105-123.
18. Nagalakshmi D, Sastry VRB, Katiyar RC, Agarwal DK, Verma SVS. Performance of broiler chicks fed on diets containing urea ammoniated neem (*(Azadirachta indica)* kernel cake. British Poultry Science, 1999; 40:77-83.
19. Paul BN, Haque N, Garg AK. Effect of feeding neem seed kernel cake (*Azadirachta indica*) on rumen enzyme of Buffalo. *Indian Veterinary Journal*, 1996; 73:720-728.
20. Uko OJ, Kamalu TN. The neem tree: Uses and potentials. Nigerian Journal of Experimental and Applied Biology, 2001; 2(2):223-229.
21. Hassan M, Auta J, Abdulllahi S. Replacement Value of Neem (*Azadirachta indica*) Seed Cake for Soya Bean Meal in the Diet of African Catfish *Clarias gariepinus* Fingerlings. *Nigerian* Journal of Fisheries and Aquaculture. 2015; 3(1, 2):55-61.
22. Sastry VRB, Agrawal DK. Feeding of water washed neem (*Azadirachta indica*) seed kernel cake to growing goats Small Ruminant Research, 2005; 15(2):105-111.
23. Aruwayo A, Maigandi SA, Malami BS, Daneji AI. Growth performance of growing Uda lambs fed graded levels of alkali treated neem kernel cake. Journal of Science and Technology Resource, 2010; 9(4):119-122.
24. Nath KS, Rajagopal, Garge AK. Water washed neem (*Azadirachta indica*) seed kernel in cattle feed. Journal of Agricultural Science. 1983; 101:323-326.
25. Sastry VRB, Agrawal DK. Utilization of water washed neem (Azadirachta indica) seed kernel cake as a protein source for growing pigs. Journal of applied animal research. 1992; 1(2):103-107.
26. Reddy KCV. *Performance* Of Buffalo *(Bubalus Bubalis)* Calves Fed Alkali Treated And Urea-Ammoniated Neem *(Azadirachta Indica A. Juss)* Seed Kernel Cake Incorporated Rations (Doctoral dissertation, Indian Veterinary Research Institute; Izatnagar), 1992.
27. Fajinmi AO, Adedeji SK, Hassan WA, Babatunde GM. Inclusion of non-conventional feedstuffs in rabbit concentrate ration, a case of neem seeds. Journal of Applied Rabbit Research, 1989; 13:125-128.
28. Lenka S, Giri SS, Paul BN. Nutrient digestibility and gastro-intestinal enzyme activity of *Cyprinus carpio* (var. communis) fingerlings fed water washed neem seed cake incorporated diets. Indian Journal of Animal Sciences. 2010; 80(5):486-489.