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Tobacco (*Nicotiana tabacum*) - A novel and futuristic sedative for fish transport in India

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Abstract

Generally, fishes are quite sensitive to aquaculture practices like handling, transportation, sizing, and grading, weighing, stripping, blood collection, surgery *etc.* among which transport is considered as one of the most stressful procedures which results in loss of equilibrium, reduced activity and ultimately, death. Stress induced mortality during live fish transport can be lowered by the application of sedatives that silence and immobilize the activity of the fishes. So far, researchers have tested the efficacy of different sedatives over different fish species. These studies reveal that some sedatives are expensive and unavailable while some are toxic and easily available. Till date, MS-222 is the only sedative approved by the USFDA to be used on food fish transport which also consists of many drawbacks such as high cost, low pH and low efficacy on plasma cortisol control. Therefore, in search of safe, effective and inexpensive sedative, tobacco is considered to be a novel and futuristic sedative in replacing the other expensive and toxic drugs owing to its traits like natural origin, cost efficiency, local availability, biodegradability and non-toxic to fishes and humans.

Keywords: Fish, MS-222, tobacco, anaesthetic, sedative, fish transport

1. Introduction

Aquaculture industry continues to expand around the world due to the rising global demand for seafood coupled with the dwindling of the wild fish stocks. Fishes cultured undergo a multi-phase of stress from several stressors such as transportation, grading, weighing, stocking which are unavoidable in aquaculture [1], consequently resulting in poor performance, increased susceptibility to disease and mortality in extreme cases. In order to minimize the mortality induced by stress, the fishes are usually sedated and immobilized by using sedatives before handling [2, 3].

Sedation is a mild anaesthetic condition used for simple procedures such as handling, weighing, simple marking and imaging [3]. Sedatives are liable to be beneficial in fish transportation by arresting the physical activity and fish stress during handling and by reducing mortality as well when exposed to severe and repeated stressors [4]. Sedative agents, used must have the traits such as rapid induction and recovery time, high solubility, non-toxic to fish and humans, no residual effect, rapid withdrawal period, availability and low cost [5]. At present, only one sedative is approved by the USFDA to be used on food fish *i.e.* MS-222, apart from its demerits like high cost, low pH and low efficacy on plasma cortisol control [6].

Many sedatives such as tricaine methane sulphonate (MS-222), benzocaine and quinaldine are expensive and are found unavailable in developing and under developed countries while few are locally available and are toxic. To solve the problem of scarce and expensive sedatives, some researchers have experimented with low doses of crude extracts of piscicidal plant material as sedatives for fish [7, 8]. Tobacco is the common name of the plant *Nicotiana tabacum* which consists of different phytochemicals that are known to be narcotic. Few works have been done in Nigeria using tobacco as anaesthetic [9] and piscicide [10]. Agokei and Adebisi [9] used aqueous and alcoholic extracts of tobacco as an anaesthetic on Nile tilapia, *Oreochromis niloticus* to check its efficacy during handling procedures of tilapia. They have reported that aqueous extract is more effective than alcoholic extract as it had a lower effective dose (4-4.5 g/L) and a comparable recovery time (2-5 min). Jegede and Olanrewaju [10] studied the piscicidal effect of tobacco leaf dust on African giant catfish (*Heterobranchus bidorsalis*) fingerlings.

They have showed that the median lethal concentration (LC₅₀) for the fingerlings exposed to *N. tabacum* leaf dust toxicity is 0.40 g/L and also reported the remarkable behavioural and histological changes in the exposed fishes.

2. Tobacco

Linnaeus derived the genus *Nicotiana* using French diplomat's name Jean Nicotine de Villeman. He is the one who introduced tobacco plant in France in 1560 from Brazil for the treatment of different ailments which was further spread to rest parts of Europe [11]. Tobacco, *N. tabacum*, is an herbaceous annual or perennial plant of the family Solanaceae (Night shade) grown for its leaves.

2.1 Description

The tobacco plant consists of simple and oval leaves along with a thick, large and hairy stem [12]. The tobacco plant produces white, cream, pink or red flowers which grow in large clusters, are tubular in appearance and can reach 3.5-5.5 cm (1.25- 2 inch) in length. It is an annual plant (surviving only one growing season) reaching 1.2-1.8 m (4-6 ft.) in height.

2.2 Distribution

Nicotiana tabacum, the plant which has now been raised for commercial tobacco production, is probably of South American origin, while *Nicotiana rustica* originated from North America is the other major species carried around the world [13]. Both species are found distributed from Florida to New Mexico, to Massachusetts, New York, Southern Ontario and Minnesota.

2.3 Active ingredients

Tobacco is commonly considered as narcotic and encompass many uses as pesticide, piscicide, molluscicide and

anaesthetic since it contains many phytochemicals like nicotine, anabasine (an alkaloid similar to the nicotine but less active), glucosides (tabacine, tabacine), 2,3,6-trimethyl 1,4-naphthoquinone, 2-methylquinone, 2-naphthylamine, propionic acid, anathaline, anthalin, anethole, acrolein, anatabine, cembrene, choline, nicotelline, nicotianine and pyrene [14]. Among the phytochemicals, nicotine is the most important and active ingredient which contributes between 2-5% dry weights of leaves [15, 16]. Pyridine and pyrrolidine ring constitute the nicotine (C₅H₄N)-CH-(CH₂)₃-N-(CH₃). It is found more in roots and is transported to the leaves for storage. It is volatile inflammable oil which is highly alkaline, with an acrid smell and a burning taste. Nicotine is readily soluble in water and in other non-polar solvents like alcohol, chloroform, ether and kerosene [17].

2.4 Benefits

Tobacco is a natural and novel product which has the potential to heal and protect when used effectively but has the ability to harm when abused. Aleem [18] suggested that tobacco leaf dust can be used as a sedative and anaesthetic due to its low cost, local availability and complete degradability. Musa *et al.* [19] have reported that the toxicity of tobacco is negligible within three days after introduction indicating the fact that tobacco is bio-degradable and environmentally safe. Wan *et al.* [20] have also pointed out that tobacco and tobacco based products are less harmful to fishes. Tobacco is a much effective plant meeting five of the eight criteria for an ideal anaesthetic [5] with the favourable traits such as low cost, local availability, biodegradability, relative safety to humans and fish since being a natural product [9]. Therefore, cheap and eco-friendly tobacco could be a novel and better alternative to costly and toxic synthetic sedatives and anaesthetics.

Table 1: Cost effectiveness of tobacco in comparison with other sedatives commonly used in aquaculture practices

| Sl. No. | Anaesthetic | Quantity | Price (U.S. dollars) | Price (INR) | Supplier |
|---------|---|----------|----------------------|-------------|-------------------------|
| 1. | Aquacalm™ (Metomidate hydrochloride) | 50 g | 495 | 33,630 | Western chemical, Inc |
| 2. | Tricaine - S (Tricaine methanesulphonate) | 100 g | 149 | 10,123 | Western chemical, Inc |
| 3. | Aqui-S™ | 100 g | 67.50 | 4585 | Aqui-S New Zealand Ltd. |
| 4. | Clove oil (100% pure) | 10 ml | 13.87 | 942 | Amazon.com |
| 5. | Benzocaine | 500 g | 49.3 | 3349 | Sigma Aldrich |
| 6. | 2-Phenoxyethanol | 1 l | 31.3 | 2126 | Sigma Aldrich |
| 7. | Quinaldine (GC grade, min 90%) | 1 l | 84.3 | 5727 | Sigma Aldrich |
| 8. | Tobacco | 1 kg | 2.2 | 149 | Tobacco Board, India |

2.5 Tobacco in India

India stands 3rd in tobacco production and exports with an annual production of about 800 million kg earning 20000 crores approximately by way of excise duty to the national exchequer, and 5000 crores approximately by way of foreign exchange every year [21]. In India, around 0.25% of cultivated land is used for the production of tobacco [13]. Among the 29 states in the country, Andhra Pradesh, Gujarat, Karnataka and UP alone together account for over 90% of the total tobacco production in India. Tobacco is also grown in other states like Bihar, Maharashtra, Orissa, Tamil Nadu, and West Bengal [22].

3. Conclusion

Fish transport is an operation which is inexorable and indispensable to aquaculture. Stress is an unavoidable factor during the transportation of fishes. Transport stress in fishes can be minimized with the help of light sedation, i.e., low

concentration of an anaesthetic. Consequently in the quest for safer, more effective, readily available, affordable, eco-friendly and easily adaptable sedative which is comparable to conventional chemical sedatives, tobacco, a popular narcotic, hoped to be a suitable alternative. Globally, there is no literature on use of tobacco as sedative for fish transport is available and it appears that experimental studies on this subject are rare. Therefore, research using tobacco as sedative would provide vital information and would be a boon for both fish and tobacco farmers and for the development of a better society.

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