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Condition Factor, Hepato-somatic Index and Gonado-somatic Index of Fish, *Channa punctatus* Collected from Sawan Nallaha, Balrampur, U.P.

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ABSTRACT

Biomarkers are measurements within an organism that respond to environmental changes and are used as bio-monitoring tools that reflect physiological changes induced by exposure to pollutants. The condition factor (K), hepatosomatic index (HSI) and gonado-somatic index (GSI)of fish, *Channa punctatus* was used to assess the effects of industrial pollutant stress. For this study, *Channa punctatus* was collected from Sawan Nallaha, a small lotic waterbody in all the seasons (Summer, monsoon and Winter). Fish collected from the non-polluted site had the higher condition factor (K) HSI and GSI as compared to fish collected from polluted site that received the industrial effluent and domestic sewage. K, HSI and GSI are simple and cost-effective bio-monitoring tool and can be used in pollution monitoring.

Keywords*:* Condition factor (K), HSI, GSI, *Channa punctatus*, Biomarkers.

INTRODUCTION

India is one of the leading industrialized countries of world with good industrial infrastructure. This has caused production of industrial effluent which has various types of pollutants that are discharged into the waterbodies and degrade the aquatic environment. All these changes consequently deteriorate the water quality of water bodies and led to the aquatic pollution. Pollution affects all the living being which is exposed to such environment. It disturbs behavior, biological activities, metabolism, physiology and overall performance of the organism.

The growth of fish is responsive to various environmental factors, such as physico-chemical and biological factors of the waterbodies. Eco-toxicology provides a number of biomarkers that can be used to estimate the effects of pollutants. Biomarker is an indicator of stress agent that is somehow affecting the organism ability to grow, reproduce, survive and adapt in a given environment (Tiwari and Prakash, 2021). Basics of biomarker are the capability of an organism to adapt to subtle changes in the environment. This adaptation is mechanistically based on changes in molecular and biochemical processes within the cellular metabolism in response to climate changes. Alterations in these processes can lead to modification in cellular structure, tissue organizations and so on up the hierarchical level of biological organizations. Basic concept of the biomarker's approach to assess adverse effects or stress is based on the hypothesis that effects of stress are typically manifested at lower levels of biological organization before disturbances are realized at the population, community or ecosystem level (Adams, 1987).

In environmental pollution context, biomarkers often promise as sensitive indicator demonstrating that toxicant has entered organism, distributed between tissues and is electing toxic effect at targets. Good biomarkers are sensitive indices of both pollutants bioavailability and early biological response. Regarding the aquatic habitats fishes are considered to be most significant biomonitors for the estimation of metal pollution level (Benaduce *et al*, 2008),water borne and sediment deposited toxicants (Viarengo,*et al*. 2007).The integrated use of biomarkers and bio-indicators is an evaluation tool, science they are effective means to determine the impact of pollution in the aquatic environment (Pandit *et al.,* 2019).

Hepatosomatic index is the main indicator of metabolic activity in animals (Verma and Prakash, 2019). The hepato-somatic index (HSI) is a bio-indicator of contaminant exposure so it is used in fisheries science as an indicator of energy reserves in the liver. It is the ratio of liver weight and body weight. Gonado-somatic index (GSI) is also a bio-indicator that supplies structural information to respect of health, reproduction of fish, breeding season of fish and maturation status of gonads (Kaur, *et al*., 2018). It is an important tool in establishing the breeding period in animals and has been successfully employed in fishes (Saxena, 1986). Liver forms an important organ of the body and due to vitelogenesis, liver play an important role in the gonadial development. Hence, hepato-somatic index has been correlated with gonado-somatic index. Production of gametes in fishes is greatly influenced by changing in the environmental conditions. Organic and inorganic pollutants contaminate aquatic environments and are mainly responsible for changes in physio-chemical characteristics of water.

Condition factor has been used as an indicator of health in fishery science since the beginning of the 20th century (Froese, 2006). It is a quantitative and integrative bio-indicator, and provides information regarding alterations fish physiological status and may be used for comparing populations living in certain feeding, climatic and other conditions. It can be used to compare the inter- and intra-specific "condition", "fatness" or well-being of fish from the same or contrasting habitats, it is a useful index for the monitoring of feeding intensity, age and growth rates in fish. CF is sensible to stress in natural environment (Pandit *et al*., 2019).Condition factor reflects general health state of fish which differs according to the environmental factors, age, sex and reproduction period. Condition factor is a useful index for monitoring of feeding intensity, age and growth rates in fish. It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to access the states of aquatic ecosystem in which fish live (Prakash and Verma, 2019).

Fish populations are more vulnerable as they are the direct recipient of virtually every form of human as well as animal wastes. The IUCN (International Union for Conservation of Nature) Red list (1996) records 734 fish species as threatened and 92 species as extinct worldwide. Water pollution is the biggest contributor to this decline. Therefore, the present study was devised to determine the condition factors along with hepato-somatic and gonado-somatic indices of some food fishes were considered for determining the suitability of aquatic body for survival and breeding activities collected from Sawan Nallaha, a lentic fresh waterbody.

MATERIAL AND METHODS

The Fish, *Channa punctatus* was collected from two different sites of Sawan Nallaha in four seasons *i.e*. Spring, Summer, Winter and Monsoon. Site-1 was upstream *i.e*. about 1.5 Km before confluence of nallaha congaing industrial effluents of Sugar factory Balrampur and its distillery unit along with domestic sewage and Site-2 was downstream *i.e*. about 1.0 Km after discharging the industrial effluent and domestic sewage in Sawan Nallah, thus covering both polluted and unpolluted areas of the Sawan Nallaha.

The fish samples were examined in the laboratory immediately after collection. The fish of different size or length (cm) were measured by using fish measuring band where as total weight (g) of fish, total weight of liver and gonads was recorded with the help of electronic balance.

The total length (Cm) of fish, total weight of the fish, total weight of the gonad and liver were used to determine the Fulton's condition factor (K), the somatic condition factor (KS), hepato-somatic index (HSI) and gonad-somatic index (GSI) of each fish by using the following formula.

$$\text{Fulton's Condition Factor (K)} = \frac{W \times 100}{L^3}$$

Where W= Weight of fish, L = Total length of fish

$$\text{Gonado-somatic index (GSI)} = \frac{\text{Weight of the ovary}}{\text{Weight of the Fish}} \times 100$$

$$\text{Hepato-somatic index (HSI)} = \frac{\text{Weight of the Liver}}{\text{Weight of the Fish}} \times 100$$

RESULT AND DISCUSSION

Condition factor (CF) is an estimation of general well-being of fish (Oribhabor *et al*. 2011) and is based on the hypothesis or assumption that heavier fish (at a given length) are in better condition than the lighter ones (Ogamba *et al*. 2014). The condition factor of 1.0 or greater indicates the good condition of fish while less than 1.0 shows bad condition (Abobi, 2015). Condition factor is a useful index for estimating growth rate and age and for assessing environmental quality (Navarro *et al*. 2010; Olopade and Tarawallie 2014). The condition factor can be influenced by season, sex, type of food organism consumed by fish, age of fish, amount of fat reserved and environmental conditions (Anene 2005; Abowei 2009).

Table1. Condition factor (K), Hepato-somatic index (HIS) and Gonado-somatic index (GSI) of *Channapunctatus* procured from two sites (Polluted and Non-polluted) of SawanNallaha

Seasons / Spawning Phase	Condition Factor (K)		Hepato-Somatic Index (HIS)		Gonado-Somatic Index (GSI)	
	Site-I (Non Polluted)	Site-II (Polluted)	Site-I (Non Polluted)	Site-II (Polluted)	Site-I (Non Polluted)	Site-II (Polluted)
Summer/ Pre-spawning	1.08±0.08	0.86±0.06 (-20.37%)	1.65±0.10	1.48±0.07 (-10.30%)	2.89±0.09	2.35±0.04 (-18.68%)
Monsoon/ spawning	1.02±0.05	0.76±0.09 (-25.49%)	1.79±0.15	1.61±0.12 (-10.05%)	2.24±0.34	1.87±0.09 (-16.52%)
Winter / Post-spawning	1.04±0.07	0.81±0.05 (-22.12%)	1.95±0.13	1.81±0.11 (-7.18%)	2.38±0.14	2.04±0.12 (-14.29%)
t at df =2	0.002 ($P<0.01$)		0.005 ($P>0.01$)		0.02($P>0.05$)	

In the present study the highest value of condition factor (K) was observed during summer season or pre-spawning phase indicates that overall condition of fish seems to be improved and fish approaches towards maturing stage. The decline of condition factor of the fish during monsoon season or spawning phase may be related to fish being exhausted due to spawning activity and also due to utilization of energy source for spawning activity. Spawning is a typical stage in the life cycle of fishes, often involving a substantial energic investment (Jobling, 1994). During winter season or post spawning phase, the value of condition factor again increases which indicate that during post-spawning fishes recover in the post-spawning. Dasgupta (1988) reported that seasonal factor influences the condition factor in fishes.

In the present study Hepato-somatic index showed highest level in winter season, which decreased in monsoon and reached to the lowest level in summer season. HSI of fish, *Channa punctatus* collected from polluted site was significantly decreased in comparison to fish collected from non-polluted site in all the seasons. Bekmezci (2010), reported that heavy metals decreased HSI in fish probably due to depletion of energy reserves in liver. Thus stress condition developed due to water pollutants and the excess usage of energy reserves in response to increase in requirement might cause the decrease in HSI. The decrease in HSI during pre-spawning phase or summer season indicates the stored hepatic contents are made available to the gonads for development during spawning phase or monsoon season. Singh and Singh (1979) studied the relationship between HSI and GSI in the fish *H. fossilis* and found that high HSI during preparatory and post spawning and low levels during pre-spawning and spawning.

Higher condition factor (K) and lower HSI occurred during the summer season and pre-spawning phase. It is suggested that fish adapted to stressful conditions and take advantage on food availability from organic loads or unoccupied niches by lesser tolerant species, increasing K. Thus it can be concluded that higher HSI values were directly associated with environmental stress whereas the higher K values are related to availability of food resources derived from organic loads or other sources.

Gonadosomatic index is other important parameter that reflects both the state of population for the continuity of generation and changes during stress condition. In the present study industrial effluent might have toxic effect in gonads, resulted a decrease in GSI of *Channa punctatus* collected from polluted site of Sawan Nallaha. In the present study, GSI values of fish, *Channa punctatus* collected from the polluted site of Sawan Nallaha were decreased significantly ($p < 0.05$) as compared to fishes collected from the non-polluted site in all the seasons. Seasonal change in the GSI was found to be high prior to spawning and declined after spawning. Seasonal changes in HSI showed that the values of HIS was higher during the resting period and during maturing stages and lower values of HSI was noticed when the gonads are in ripened stage suggesting that the liver supports the vitellogenic activity (Thirumala and Kiran, 2020).The fecundity of *Channa punctatus* was found to decrease due to their exposure to various pollutants especially heavy metals present in the water of Sawan Nallaha water (Prakash, 2022). These results are in accordance with these findings (Dewi and Probowo, 2017). Martinez *et al*., (2012) reported that, GSI of fish, *Mullus barbatus* decreased under the effect of heavy metals, possibly due to structural deformation of DNA and an increase in liver ethoxyresorufin-O-deethylase enzyme activity and probably due to inhibition of enzymes functioning in synthesis and release of reproductive hormones. There is also some argument that CF can increase in polluted and rich organic matter areas due to increased feeding sources used by tolerant species that take advantage of this resources (Lohani *et al*., 1994). Based on the results of the present study, it can be concluded that water pollutants present in industrial effluents and domestic sewage affects negatively on the biological and reproductive activities of fishes inhabiting in these polluted water bodies. The results of present study provide novel information on this subject for a native fish species and could be useful for future comparisons with data of fishes belonging to other environments. The outcome is helpful for selective breeding programme, conservation and sustainable fishery management of this commercially important fish.

In the present study, Pearson's correlations showed significant positive correlation of condition factor (K) with HIS and GSI and also between HSI and GSI (Table 2).

Table 2. Correlation Coefficient and Regression Equation of Condition factor (K), Hepato-somatic index (HIS) and Gonado-somatic index (GSI) of *Channa punctatus*

Correlation b/w Parameters	Correlation coefficient (r)	Regression equation (Y)
K Vs HSI	0.73977	Y= 0.86157446 + 0.91931045X
K Vs GSI	0.81623	Y = 0.32716486 + 2.1197505 X
HIS Vs GSI	0.96026	Y= -1.1466085 + 2.0067687X

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REFERENCES

Abobi, S.M. (2015). Weight-length models and relative condition factors of nine (9) freshwater fish species from the Yapei stretch of the White Volta, Ghana. *Elixir Appl Zool*.; 79:30427-30431.

Abowei, J.F.N. (2009). The condition factor, length-weight relationship and abundance of *Elopsseneganensis* (Regan, 1909) from Nkoro River, Niger Delta, Nigeria. *Adv J Food Sci Technol*.; 2(1):16-21.

Adams, S.M. (1987). Status and use of biological indicators for evaluating the effects of stress on fish. *In: S.M. Adams (ed.). Biological Indicators of Stress in Fish*, Vol. 8. Am. Fish Soc. Symp. pp. 8–18.

Anene, A. (2005). Condition factor of four chichlid species of a man-made lake in Imo state, south-eastern Nigeria. *Turkish J Fisheries Aquatic Sci*. 5:43-47.

Bekmezeci, H.D. (2010).

Asago Scyhan Ovasr Drenaj Sistemlerindeki Kirlilik Etmenlerinin *Clarias gariepinus*'da Toksiketkileri, Cukurova Universitesi, Fen Biyoliji ABD, Doktora Tezi,145.

Benaduce, A.P.S., Kochhann, D., Flores, É.M.M., Dressler, V.L. and Baldisserotto, B. (2008). Toxicity of cadmium for silver catfish *Rhamdiaquelen* (Heptapteridae) embryos and larvae at different alkalinities. *Arch Environ Contam Toxicol.* 54: 274-282.

Lohani, B.N. and Santos, N.L. (1994). "Environmental impacts of integrated fisheries development in the Bicol River basin, the Philippines," *International Journal of Water Resources Development*, 2(1}: 61-74, tp://dx.doi. org/10.1080/07900628408722308.

Dewi, N.K. and Probowo, R. (2017). Determination of Liver Somatic Index (LSI) and Gonadosomatic Index (GSI) Value of Crap (*Cyprinus carpio*) and Nile tilapia (*Perca fluviatilis*), *International Journal of Scientific and Research Publications*, 7(6): 220-223.

Froese, R. (2006). Cube law, condition factor and weight-length relationship: history, meta-analysis and recommendations. *J. Appl. Ichthyol*., 22:241-253.

Kaur, S., Singh, P. and Hassan, S.S. (2018). Studies on Gonado-somatic index (GSI) of selected fishes of River Sutlej, Panjab. *Journal of Entomology and Zoology Studies*. 6(2): 1274-1279.

Martinez-Gomez, C., Fernandez, B., Benedicto, J., Valdes, J., Campillo, J.A., Leon, V. M. and Vethaak, A.D. (2012). Health status of Red Mullets from polluted areas of the Spanish Mediterranean Coast, with special reference to Portman (SE Spain), *Marine Environmental Research*, 77:50-59.

Navarro, J.T. (2010). Zetina-Rejon F, Arreguin-Sanchez NE. Length-weight relationships of demersal fish from the Eastern coast of the mouth of the Guf of Californa. *J Fish Aquat Sci*. 5:494-502

Ogamba, E.N., Abowei, J.F.N. and Onugu, A. (2014). Length-weight relationship and condition factor of selected finfish species from Odi River, Niger Delta, *Nigeria. Journal of Aquatic Science*. 29(1A):1-12.

Olopade, J.O. and Tarawallie, S (2014). The length-weight relationship, condition factor and reproductive biology of *Pseudotholithus senegalensis* (Valenciennes, 1833) in Tombo Western Rural District of Sierra Leone*. Afr J of Food, Agric, Nutrition and Devment*. 14(6):2176-2188.

Oribhabor, B.J., Ogbeigbu, A.E., Udo, M.T.(2011). The length-weight relationship of brackish water/marine fish species assemblage in Niger Delta mangrove creek, Nigeria. Current Research Journal of Biological Science. 3(6):616-621.

Pandit, D.N., Priyanka, Gupta, M.L. (2019). Hepato-Somatic Index, Gonado-Somatic Index and Condition Factor of *Anabas testudineus* as Bio-Monitoring Tools of Nickel and Chromium. *International Journal of Innovations in Engineering and Technology*. 12 (3): 025-028.

Prakash, S, (2022). Bioaccumulation and Bioconcentration factor of heavy metal in the tissue of freshwater fish

Channapuntctatus collected from Swan Nallaha, Balrampur, Uttar Pradesh,India. *Intern.j.Zool. invest*.8(1):389-396.https://doi.org/10.33745/ijzi.v08i01.042

Prakash, S. and Verma, A.K.(2019). Length-weight relationship and Condition factors of fresh water fishes of Baghel Taal of Bahraich (U.P.), India. *J. Exp. Zool. India*. 22(1):343-345.

Saxena, R. (1986). Comparative studies on the gonado somatic index in two bottom feed ersteleosts. *Indian J. Phy. Nat. Sci*., 6A: 39-47.

Singh, A.K. and Singh, T.P. (1979). Seasonal uctuation in lipid and cholesterol content of ovary, liver and blood serum in relation to annual sexual cycle in *Heteropneutes fossilis* (Bloch) *Endo krinologie*, 73: 47-54

Thirumala, S. and Kiran, B. R. (2020). An overview on biology of fresh water fishes in the lentic water bodies of Shivamogga and Chikmagalur districts, Karnataka. *Gedrag & Organisatie Review*. 33(2):2576-2584.

Tiwari, S. and Prakash, S. (2021). Fish as Biomarkers of aquatic pollution: A review. *Proceeding of International Virtual Seminar on Recent Trends in Life Sciences and Biotechnology*. Rakesh Book Service, New Delhi. Pp159-162.ISBN: 978-93-84998-83-7.

Verma, A.K. and Prakash, S. (2019).Impact of arsenic on haematology, condition factor, hepatosomatic and gastrosomatic index of a fresh water cat fish, *Mystusvittatus. International Journal on Biological Sciences*. 10 (2) : 49-54.

Viarengo, A., D.M. Lowe, C. Bolognesi, E. Fabbri and A. Koehler. (2007). The use of biomarkers in biomonitoring: a 2-tier approach assessing the level of pollutant-induced stress syndrome in sentinel organisms. *Comp. Biochem. Physiol. Part C Toxicol. Pharmacol*. 146(3): 281–300.