Short note

The Carbohydrate Profile of Riverine Fruits in the Natural Diet of Malaysian Mahseer, *Tor tambroides*

SAIRATUL DAHLIANIS ISHAK[1]*, JOSEPHINE DORIN MISIENG[2], ELHAM TAGHAVI[3], AMBOK BOLONG ABOL-MUNAFI[1] and MOHD SALLEH KAMARUDIN[4]*

[1] *Higher Institution Centres of Excellence (HiCoE), Institute of Tropical Aquaculture and Fisheries, Universiti Malaysia Terengganu, Kuala Nerus, Terengganu*
[2] *Inland Fisheries Division, Department of Agriculture Sarawak, Sarawak*
[3] *Faculty of Fisheries and Food Science, Universiti Malaysia Terengganu, Kuala Nerus, Terengganu*
[4] *Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, Serdang, Selangor*

**Corresponding authors:* sairatul.ishak@umt.edu.my, msalleh@upm.edu.my

The Malaysian mahseer, *Tor tambroides* (Bleeker, 1854), is a commercially important aquaculture species that is widely popular as ornamental and game fish, and its flesh touted as a tasty delicacy (Lau et al., 2021). A high-quality individual is priced at MYR600 kg^{-1} (approximately USD175 kg^{-1}) making it the highest valued freshwater fish cultured in Malaysia (DOF, 2021). Generally, fish from the genus *Tor* are omnivores with several species recognized as frugivores such as Semah mahseer (*Tor duoronensis*), Chinese mahseer (*Tor sinensis*), and Javan mahseer (*Tor tambra*) (Kamarudin et al., 2014). The roles of carbohydrates in the diet of the omnivorous Malaysian mahseer have not been fully understood, and this species is reported to have an optimal carbohydrate requirement of 23.4% (Ishak et al., 2016). The data collection in this article characterizing the carbohydrate profile of seasonal riverine fruits found in the diet of Malaysian mahseer in its natural habitat is shown in Figure 1. The profile comprised of: (i) total carbohydrate (made up of crude fibre and nitrogen-free extract (NFE)); and (ii) simple carbohydrates or sugars (monosaccharide (glucose and fructose) and disaccharide (sucrose and maltose). Fruits from six seasonal riverine tree species; Football fruit or "Kepayang" (*Pangium edule*), Pacific almond or "Dabai" (*Canarium odontophyllum*), "Neram" (*Dipterocarpus oblongifolius*), Guayabilla or "Jambu Ara" (*Bellucia pentamera*), Cottonfruit or "Sentul" (*Sandoricum koetjape*), and Paddy oats or "Melinjau" (*Gnetum gnemon*), were reported to be part of the natural diet of Malaysian mahseer (Tan, 1980; Misieng et al., 2015). These wild fruits are edible and both human and animal consume the fruits for its high carbohydrate and lipid content (Ambak and Jalal, 2006). Bami et al. (2017) studied the effects of *C. odontophyllum* oil incorporated in the Malaysian mahseer diet and found that although the fruit is consumed in the wild, nonetheless the extracted concentrated crude oil is not a suitable lipid source indicating a possible purpose of consuming for dietary carbohydrate. Samples for this study were obtained from the collection of the Department of Aquaculture, Universiti Putra Malaysia, Serdang, and subjected to high-performance liquid chromatography (HPLC) analysis following AOAC official method 982.14. Briefly, samples in powder form were subjected to direct extraction in acetonitrile:water (1:1, v:v) with no heat, subsequently filtered through a 0.45µm nylon syringe filter prior to chromatographic separation. Filtered samples were then injected into Prevail Carbohydrate ES column (250mm × 4.6mm i.d., 5µm) on a Varian 385-LC Evaporative Light-Scattering Detector ELSD (Agilent Technologies, USA); evaporator, 40°C; nebuliser, 40°C; equipped with a JASCO PU980 pump. The mobile phase was 3 parts acetonitrile to 1 part water (75:25, v/v) with a nitrogen flow rate of 1.0 mL min^{-1}. The sugar composition was determined as the percentage of area under chromatographic peaks over the total area of peaks. Data in Table 1 showed that *B. pentamera*, *D. oblongifolius* and *S. koetjape* have more than 70% of total carbohydrate compared to *P. edule, C. odontophyllum* and *G. gnemon*, with high crude fibre content in *C. odontophyllum* (33.10%) and *D. oblongifolius* (25.30%). Comparatively, *B. pentamera* was shown to have the highest content of glucose (2.391±0.142 g $100g^{-1}$) and fructose (8.168±0.286 g $100g^{-1}$), whereas the highest content of sucrose was *C. odontophyllum* (0.846±0.071 g $100g^{-1}$). Meanwhile, the highest NFE contents were the fruits *B. pentamera* (69.22%) and *S. koetjape*

(70.79%). No glucose was detected in the fruits of the *P. edule* and *C. odontophyllum*; whereas maltose was not detected in any samples. The non-digestible carbohydrate constituents may contribute to the fish dietary fibre intake, whereas the sugars are highly digestible energy source for vertebrates and vital in maintaining bodily functions. These analyses were carried out to add baseline data on the nutritional content of these fruits which subsequently will provide a basis in understanding the Malaysian mahseer's natural diet and its feeding behavior. Knowing the quality of natural diet can assist in better feed formulation for the aquaculture feed industry. Inadvertently, this data can also be used for the conservation of threatened riverine trees due to river inundation and other anthropogenic activities.

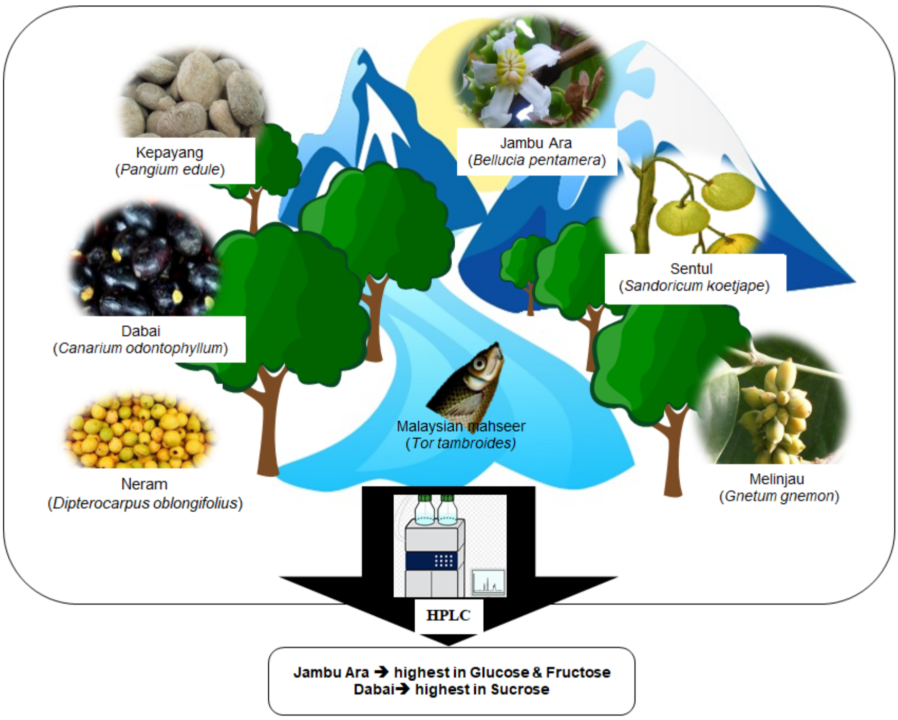

Figure 1. Graphic representation of the data characterizing the carbohydrate profile of seasonal riverine fruits found in the diet of Malaysian mahseer in its natural habitat.

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Competing Interests

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

Table 1. Carbohydrate composition (% as fed basis) of insoluble (crude fibre) and soluble carbohydrate (nitrogen free extract/NFE), and sugar composition (g $100g^{-1}$ dry matter of dried sample) of riverine fruits in *T. tambroides* diet

Riverine fruit	Crude fibre[1]	Nitrogen Free Extract[1]	Total carbohydrate[2]	Monosaccharide		Disaccharide	
				Glucose	Fructose	Sucrose	Maltose
Football fruit/ "Kepayang" *Pangium edule*	12.29	12.96	25.25	*	0.100 ± 0.001^{c}	0.017 ± 0.001^{d}	*
Pacific almond/ "Dabai" *Canarium odontophyllum*	33.10	17.39	50.49	*	0.100 ± 0.001^{c}	0.846 ± 0.071^{a}	*
"Neram", *Dipterocarpus oblongifolius*	25.30	45.57	70.87	0.100 ± 0.001^{c}	0.199 ± 0.141^{c}	0.498 ± 0.000^{b}	*
Guayabilla/ "Jambu Ara" *Bellucia pentamera*	0.95	69.22	70.17	2.391 ± 0.142^{a}	8.168 ± 0.286^{a}	0.099 ± 0.000^{c}	*
Cottonfruit/ "Sentul" *Sandoricum koetjape*	0.42	70.79	71.21	0.399 ± 0.141^{b}	0.349 ± 0.070^{b}	0.598 ± 0.141^{ab}	*
Paddy oats/ "Melinjau" *Gnetum gnemon*	13.73	52.23	65.96	0.100 ± 0.000^{c}	0.150 ± 0.070^{c}	0.150 ± 0.070^{c}	*

Each reported sample values were mean ± standard deviation, subjected to one-way analysis of variance (one-way ANOVA) and differences between means were tested using Duncan's new Multiple Range Test at $P<0.05$.
[1]For comparison purposes, data from Misieng *et al*. (2015) of the same fruit samples were incorporated.
[2]Total carbohydrate = crude fibre + NFE
*Not detected

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