

Use of algae and aquatic macrophytes as feed in small-scale aquaculture

A review



Cover photographs:

Left: Woman collecting water chestnut fruits from a floodplain, Rangpur, Bangladesh (courtesy of Mohammad R. Hasan).

Right top to bottom: Sale of water spinach leaves, Ho Chi Minh City, Viet Nam (courtesy of William Leschen). Woman carrying water spinach leaves after harvest, Beung Cheung Ek wastewater lake, Phnom Penh, Cambodia (courtesy of William Leschen). Back side of a lotus leave, photograph taken in a floodplain, Rangpur, Bangladesh (courtesy of Mohammad R. Hasan).

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Preparation of this document

Recognizing the increasing importance of the use of aquatic macrophytes as feed in small-scale aquaculture, the global review on this topic was undertaken as a part of the regular work programme of the Fisheries and Aquaculture Department of the Food and Agriculture Organization of the United Nations (FAO) by the Aquaculture Management and Conservation Service 'Study and analysis of feed and nutrients (including fertilizers) for sustainable aquaculture development'. This was carried out under the programme entity 'Monitoring, Management and Conservation of Resources for Aquaculture Development'.

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Abstract

This technical paper presents a global review on the use of aquatic macrophytes as feed for farmed fish, with particular reference to their current and potential use by small-scale farmers. The review is organized under four major divisions of aquatic macrophytes: algae, floating macrophytes, submerged macrophytes and emergent macrophytes. Under floating macrophytes, *Azolla*, duckweeds and water hyacinths are discussed separately; the remaining floating macrophytes are grouped together and are reviewed as 'other floating macrophytes'. The review covers aspects concerned with the production and/or cultivation techniques and use of the macrophytes in their fresh and/or processed state as feed for farmed fish. Efficiency of feeding is evaluated by presenting data on growth, food conversion and digestibility of target fish species. Results of laboratory and field trials and on-farm utilization of macrophytes by farmed fish species are presented. The paper provides information on the different processing methods employed (including composting and fermentation) and results obtained to date with different species throughout the world with particular reference to Asia. Finally, it gives information on the proximate and chemical composition of most commonly occurring macrophytes, their classification and their geographical distribution and environmental requirements.

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Abbreviations and acronyms

APD	Apparent Protein Digestibility
BFRI	Bangladesh Fishery Research Institute
BW	Body Weight
DM	Dry Matter basis
DW	Dry weight
DWRP	Duckweed Research Project (Bangladesh)
EAA	Essential Amino Acid
FCR	Feed Conversion Ratio
FW	Fresh Weight
MAEP	Mymensingh Aquaculture Extension Project
MP	Muriate of Potash
NFE	Nitrogen-Free Extract
NGO	Non-governmental organization
PRISM	Project in Agriculture, Rural Industry Science and Medicine (an NGO)
SGR	Specific Growth Rate
TKN	Total Kjeldahl Nitrogen
TSP	Triple Super Phosphate
UASB	Upflow Anaerobic Sludge Blanket Reactor
2,4-D	2,4-Dichlorophenoxyacetic acid

Introduction

Using feeds in aquaculture (sometimes referred to as aquafeeds) generally increases productivity. However, to maximize cost-effectiveness, it is particularly useful in small-scale aquaculture to utilize locally available materials, either as ingredients (raw materials) in compound aquafeeds or as sole feedstuffs.

There is also a vital need to seek effective ingredients that can either partially or totally replace marine ingredients as protein sources in animal feedstuffs generally, in particular in aquafeeds. While this broad topic is not dealt with in this review, many introductions to the literature of the past two decades are available, including New and Csavas (1995), Tacon (1994; 2004;), Tacon, Hasan and Subasinghe (2006), Tacon and Metain (2008), New and Wijkstrom (2002), FAO (2008) and Huntington and Hasan (2009).

This review deals with the characteristics of aquatic raw materials for use as feeds in small-scale aquaculture, namely algae (principally macro-algae – commonly referred to as seaweeds) and aquatic macrophytes. Aquatic macrophytes are aquatic plants that are large enough to be seen by the naked eye. They grow in or near water and are floating, submerged, or emergent.

Information includes current and potential usage of these materials by small-scale aquafarmers for target fish and crustaceans, together with details on their classification, characteristics (including such factors as their natural distribution and environmental requirements), production and chemical composition.

The review has been divided into seven major sections: one dealing with algae; four sections on floating macrophytes (namely *Azolla*, duckweeds, water hyacinths and others); a section on submerged macrophytes; and one on emergent macrophytes. Finally, the review contains a concluding section which summarizes previous chapters.

