

Contents

	Page
INTRODUCTION	1
Historical review.	4
1. Fish silage.	7
2. Soybean meal (SBM) as fish meal replacer.	11
3. A Mixture of both FFS and SBM.	15
MATERIALS AND METHODS	19
1. Rearing facilities.	19
1.1 Experimental glass aquaria.	19
1.2 Experimental cement pond.	20
2. Experimental fish.	20
3. Experimental diets :	21
3.1 Preparation of fermented fish silage (FFS).	21
3.2 Preparation of soybean meal (BSM).	22
3.3 Preparation of mixture of both FFS and BSM (MIX).	22
4. Experimental design :	22
4.1 Experiment I : Testing fermented fish silage (FFS) as a Fish meal (FM) replacer.	22
4.1.1 Experimental diets.	23
4.1.2 Preparation and processing4.1.3 Feeding regime.	23
4.2 Experiment II : Testing boiled soybean meal (BSM) as fish meal (FM) replacer.	26
4.2.1 Experimental diets.	26
4.3 Experiment III : Testing a mixture of FFS and BSM 1:1 (MIX) as a FM replacer.	29
4.3.1 Experimental diets.	29
4.3.2 Feeding regime.	29

5. Water quality assessment.	32
5.1. Temperature.	32
5.2 Dissolved oxygen.	32
5.3 Total alkalinity ($\text{CO}_3^{=}$ and HCO_3^-).	32
5.4 Nitrites (NO_2^-) mg/l.	32
5.5 Phosphorus (mg/l.).	32
5.6 Hydrogen ion concentration (pH).	33
6. Growth performance.	33
6.1 Growth in weight.	33
7. Biological examinations of fish.	34
8. Nutritional parameters (feed utilization).	34
9. Biochemical composition.	36
9.1 Carcass composition of fish.	36
9.1.1 Moisture content.	36
9.1.2 Crude protein.	37
9.1.3 Crude lipid (ether extract).	37
9.1.4 Ash content.	37
9.1.5 Energy content.	37
9.1.6 Protein / Gross energy ratio.	37
9.2 Chemical composition and energy content of test diets	38
Proximate analysis of diets.	38
9.3 Energy content of diets.	38
9.4 Amino acids of diets.	38
10. Biochemical analysis of fish liver.	38
10.1 Determination of liver glycogen.	39
10.2 Determination of total liver lipids.	39
10.3 Determination of total liver protein.	39
11. Statistical analysis.	42
12. Economic analysis.	42

RESULTS	43
Chapter I :	43
Physico-chemical parameters in the experimental ponds or aquaria :	43
1. Temperature.	43
2. Dissolved oxygen.	44
3. Total alkalinity.	44
4. Nitrites.	45
5. Phosphates.	45
6. Hydrogen ion concentration (pH).	45
Chapter II :	50
Evaluation of different fish meal (FM) replacers :	50
Experiment 1 :	50
1. Effect of using fermented fish silage (FFS) as a fish meal (FM) replacer in <i>O. niloticus</i> diets.	50
1-1. Effect of FFS inclusion on growth performance of <i>O. niloticus</i> .	50
1-1-1. <i>O. niloticus</i> fry.	50
1-1-2. <i>O. niloticus</i> fingerlings.	55
1-1-3. <i>O. niloticus</i> grow-out.	58
1-2. Effect of using (FFS) as (FM) replacer on feed utilization parameters of <i>O. niloticus</i> .	59
1-2-1. <i>O. niloticus</i> fry.	59
1-2-2. <i>O. niloticus</i> fingerlings.	71
1-2-3. <i>O. niloticus</i> grow-out.	73
1-3. Effect of FFS inclusion within diets on the biochemical composition of <i>O. niloticus</i> .	82

1-3-1. <i>O. niloticus</i> fry.	82
1-3-2. <i>O. niloticus</i> fingerlings.	84
1-3-3. <i>O. niloticus</i> grow-out stage.	86
1-4. Effect of fermented fish silage (FFS) inclusion within diets on <i>O. niloticus</i> biological characteristics.	95
1-4-1. <i>O. niloticus</i> fry.	95
1-4-2. <i>O. niloticus</i> fingerlings.	95
1-4-3. <i>O. niloticus</i> grow-out.	96
Chapter III :	104
Experiment 2 :	104
2. Effect of using boiled soybean meal (BSM) as a fish meal (FM) replacer in <i>O. niloticus</i> diets.	104
2-1. Effect of BSM inclusion on growth performance of <i>O. niloticus</i> .	104
2-1-1. <i>O. niloticus</i> fry.	104
2-1-2. <i>O. niloticus</i> fingerlings.	108
2-1-3. <i>O. niloticus</i> grow-out stages.	109
2-2. Effect of using BSM as a FM replacer on feed utilization parameters of <i>O. niloticus</i> .	122
2-2-1. <i>O. niloticus</i> fry.	122
2-2-2. <i>O. niloticus</i> fingerlings.	124
2-2-3. <i>O. niloticus</i> grow-out.	126
2-3. Effect of BSM inclusion within diets on the biochemical composition of <i>O. niloticus</i> .	135
2-3-1. <i>O. niloticus</i> fry.	135
2-2-2. <i>O. niloticus</i> fingerlings.	137
2-3-3. <i>O. niloticus</i> grow-out.	137

2-4. Effect of boiled soybean meal (BSM) as a fish meal (FM) replacer on <i>O. niloticus</i> biological characteristics.	146
2-4-1. <i>O. niloticus</i> fry.	146
2-4-2. <i>O. niloticus</i> fingerlings.	146
2-4-3. <i>O. niloticus</i> grow-out.	147
Chapter IV :	155
Experiment 3	155
3. Effect of using a mixture of both FFS and BSM (MIX) as FM replacer in <i>O. niloticus</i> diets.	155
3-1. Effect of MIX on growth performance of <i>O. niloticus</i>	155
3-1-1. <i>O. niloticus</i> fry.	155
3-1-2. <i>O. niloticus</i> fingerlings.	159
3-1-3. <i>O. niloticus</i> grow-out.	162
3-2. Effect of using a mixture of both FFS and BSM (MIX) as a FM replacer on feed utilization parameters of <i>O. niloticus</i> .	172
3-2-1. <i>O. niloticus</i> fry.	172
3-2-2. <i>O. niloticus</i> fingerlings.	174
3-2-3. <i>O. niloticus</i> grow-out.	176
3-3. Effect of MIX inclusion within diets on the biochemical composition of <i>O. niloticus</i> .	185
3-3-1. <i>O. niloticus</i> fry.	185
3-3-2. <i>O. niloticus</i> fingerlings.	187
3-3-3. <i>O. niloticus</i> grow-out.	189
3-4. Effect of mixture (MIX) of fermented fish silage (FFS) and soybean meal (BSM) as fish meal (FM) replacer on <i>O. niloticus</i> biological characteristics.	197
3-4-1. <i>O. niloticus</i> fry.	197