

# UTILIZATION OF CARBIDE HYDRATE AS NEUTRALIZING AGENT FOR ACIDIC FISHPONDS\*

**T**he use of lime as neutralizing agent in acidic fishponds has been demonstrated to improve productivity due to its ability to enable the pond system attain conditions favorable to fish and other pond organisms. However, the increasing cost of lime in recent years has underscored the need to look for cheaper alternative sources. The preliminary works on carbide hydrate at MSU-Naawan (Daitia, 1988 and Prado, 1989) were initiated with the intention of exploiting its properties for wider application. Because of its high basic character, carbide hydrate was shown to treat effectively acid-induced soil by raising its pH in two weeks time to near neutrality. Despite its potential, its usefulness has not been utilized in aquaculture in Northern Mindanao as an alternative to lime. Fishpond owners and operators who were informed about the two studies were quite appreciative of the result but declared they were not ready to try using carbide hydrate as liming material. They expressed apprehension that carbide hydrate might leave objectionable residues in the pond soil due to its perceived residual content that may be environmentally unsafe and toxic to fishpond organisms.

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\* The Two studies presented in this Terminal Report are components of a research project entitled "Utilization of Carbide Hydrate as Neutralizing Agent for Acidic Fishponds." It is a joint undertaking of MSU Naawan Foundation, Mindanao State University at Naawan, and the Maria Christina Chemical industries (MCCI) to find better and productive ways of using MCCI's less useful and pollutive industrial by-product. The completed research on the potential utilization of carbide hydrate as a liming substance for acidic fishpond soils and its effect on the survival of sugpo, tilapia and kitong strongly indicated the possibility of using acetylene production by-product as an alternative liming material for aquaculture food production system. The MSU Naawan Foundation and Mindanao State University at Naawan greatly appreciate the financial assistance for this research project that indicates the potential of disposing of industrial solid waste in an environment-friendly and economically productive manner. Researches of this kind is supportive to the programs of protecting our environment and the Philippines 2000.

**This assumption from possible users of carbide hydrate underscores the need to conduct continuing investigations to generate more information that will provide a better understanding of carbide hydrate used as neutralizing agent in acidic fishpond soil.**

**Four distinct studies were submitted for MCCI funding to further investigate the liming usage of carbide hydrate in neutralizing acidic fishpond soils. The titles of the studies originally proposed are “Demonstration of the Neutralizing Effect of Lime and Carbide Hydrate on Acidic Soil” (Study 1); “Survival of Sugpo Fry, Tilapia and Kitong Fingerlings in Seawater with Carbide Hydrate-treated Soil Substrate Under Laboratory Condition” (Study 2); “Comparative Study of the Efficiency of Different Liming Methods of Carbide Hydrate Application” (Study 3); and “Sugpo Production in Lime and Carbide Hydrate-Treated Acidic Pond Soils” (Study 4). The title for Study 2 was revised for reason of appropriateness.**

**To date, Studies 1 and 2 are completed and the data and information obtained are presented in this Terminal Report.**

## STUDY 1

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# DEMONSTRATION OF THE NEUTRALIZING EFFECT OF LIME AND CARBIDE HYDRATE ON ACIDIC SOIL

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### Objectives

**T**he twin purposes of the study as follows: to compare the neutralizing performance of carbide hydrate on acidic soils with other materials in terms of pH development and time; and to verify the applicability of the commonly used lime requirement on carbide hydrate.

### Methodology

Study 1 was conducted on six basins containing 6cm depth of HCl acid-induced soils. The fishpond soil in the basins were manually mixed in order to obtain a uniform pH of 5.0-5.06 for trial 1 and 4.32-4.5 for trial 2. Ground Carbide hydrate (MCCI), lime hydrate (MCCI) and commercial lime (SATII) were applied separately on mud surface in solution form and agitated evenly upon application and every three days to allow penetration to the substratum. Quantity of lime materials applied was determined using the Buffer method. Every three days soil samples were collected using a 2" diameter mud corer at the 1-6 cm soil depth. This sampling excluded the undissolved lime materials on the surface. Preparation of soil samples follow standard procedures such as drying, pulverizing and sieving through a # 20 ASTM sieve. Samples from Study 1, including the preliminary

investigations, were analyzed according to the following: color by visual method, neutralizing value by HCl-NaOH titration, pH (water and mud) by pH meter at 1:1 ratio and tests for hydrocarbons as described in "A Laboratory Manual of Basic Organic Chemistry."

## Results and Discussion

### Characterization of Lime Material

**Color and Solubility.** Color of liming materials may be important in assessing the content of lime as well as the impurities. For instance, limestone purity varies from 60-90% depending upon the color. In the case of burned lime, the impurities consist of original impurities of limestone. White to milky color is common among lime materials, while the gray color of carbide hydrate is misleading, it being a characteristic color of one kind of ground limestone. It may indicate the presence of a substance that gives its characteristic smell not observed in other lime materials. Solubility tests (Table 1) conducted in a wide range of acidity revealed their behavior. At higher pH, all solutions produced an insoluble portion having color matching their dry state whereas in more acidic medium (1N HCl) the liming materials were completely soluble as compared to carbide hydrate containing a large soluble portion and insoluble gray solid which appeared to be calcium carbide residues. However, no confirmation was made.

**Neutralizing Values.** Neutralizing values of liming materials are presented in Table 1 as % calcium carbonate, the basis of comparison. Theoretically, pure calcium oxide has a calcium carbonate equivalent of 178%. Of the three liming materials, commercial lime appeared to have the highest calcium carbonate content (125.28%) compared to carbide hydrate with 120.48%. This means that the former is 1.25 and the latter 1.2 better than pure calcium carbonate in neutralizing capacity. In terms of solution pH, the three materials gave results in the range of 10.86-10.88 and 12.50-12.54 for 1 g/100mL and 1g/L solutions, respectively. Their high neutralizing capacity was further demonstrated when 1g of liming material raised the pH of 300 g of dry soil from 4.62 to range 7.58-7.8 (Table 1). These values clearly show that the neutralizing power of the

three liming materials are of the same magnitude.

*Hydrocarbon test.* The result for qualitative measurement using combustion and unsaturation test for hydrocarbons as residual substance was negative. The method used applies only to high concentration.

### **pH Development**

The changes and trend in subsurface soil pH of the liming materials are shown in Table 2. Applying these materials to soils of pH 5 and 4.5 markedly raised the subsurface soil pH after three days. This significant rise was observed in both levels (Trial 1 and Trial 2) as a result of the fast action of agitation with surface soil. The results of the succeeding sampling showed a slow rise of pH until the neutral range was reached in 15 days. This development supports the slow neutralizing effect of the method of broadcasting lime over pond bottom to percolate and react with the lower level (6 cm) as compared with a modified fast reaction method of incorporating the lime material into the soil by plowing. The pH change were shown to be in the range of 1.83 - 2.08 pH units for Trial 1 and 2.12 - 2.28 pH for Trial 2. The low performance of carbide hydrate observed in the first trial is probably due to the higher level of soil placed in the basin. In Trial 2, carbide hydrate showed better and comparable performance with commercial lime.

### **Lime Requirement**

Liming rates are dependent on soil characteristics such as pH which indicates the need for lime and texture, the adsorptive capacity of the soil and the kind and fineness of lime used. In determining the amount of lime to be applied, aquaculturists recommend the Buffer method, considered to provide accurate estimates supplied by a Table which is based on soil and buffer pH. Table 3 shows the particulars in determining the lime requirement using the Buffer method. Clay loam soil with a pH of 5.06 and 4.52 require about 4400 and 6380 kg ground carbide hydrate to give a final pH of 6.93 and 6.64, respectively, after 15 days. Similar liming rate values were also

obtained for the other lime materials. In most cases, the use of the buffer method gives final pH exceeding 7 due to the remaining unreacted lime at the surface not considered in determining the pH development, but the overall pH rarely exceeds the neutral pH range (6.5-7.5). The level of the soil is also to be considered which, in this study, is only 6 cm. If the sampling procedure specifies 10 cm depth as the area covered for neutralization then the amount of lime to be applied will also be increased. Based on the results of the study the liming rates for carbide hydrate presented in Table 4 are recommended in order to raise the soil pH to about 7.0.

It should be noted that this recommendation intended for clay loam may also be used on soil types of similar category belonging to medium and moderately fine textures such as silt-loams, silty clay loams, sandy clay and sandy clay loams. Sandy loams would require one half of the amount of the heavy loams.

### **Conclusion and Recommendation**

Carbide hydrate appears to be a promising material as neutralizing agent in acidic fishponds, as shown by its high value. Except for some extraneous substance, it has characteristics comparable with known lime materials which exhibit ability to raise soil pH to optimum range. The results of this short laboratory study can be better understood and appreciated when experiments are conducted in the field for demonstration and more observations.

### **Acknowledgement**

We are deeply indebted to the following for the completion of these studies: the MCCI, Iligan City, for financial support; the *S. guttatus* Group for the fingerlings of Kitong and Tilapia and finfish pellets; the MSU Naawan IPPP for the sugpo fry and the brine shrimp nauplii; Jenis Amarga and Bebot Gaid for helping in the sampling and preparation of samples for analysis; and Recot Roa and Nonon Mamauag for the illustration and bookbinding. The MSU Naawan and the MSU Naawan Foundation are gratefully appreciated for the research facilities and administrative support, respectively.

**Table I. Comparison of Some Physical and Chemical Properties of Liming Materials**

<b>I - <u>Physical Characteristics</u></b>			
<b>A. Color</b>		<b>B. Solubility (1N HCl)</b>	
Carbide hydrate - gray (MCCI)		Large portion soluble except gray residues	
Lime hydrate - whitish (MCCI)		Completely soluble	
Commercial lime - milky (SATII)		Completely soluble	
<b>II - <u>Chemical Characteristics</u></b>			
<b>A. Neutralizing Value:</b>			
	<u>% CaCO<sub>3</sub></u>	<u>CaO Equivalent*</u>	
Carbide hydrate (MCCI)	120.48	67.46	
Lime hydrate (MCCI)	110.88	62.09	
Commercial lime (SATII)	125.28	70.19	
*computed theoretically			
<b>B. Solution pH</b>			
	1g/100ml	1g/L	pH of 1g liming material + 300g soil of pH 4.62
Carbide hydrate (MCCI)	10.86	12.54	7.80
Lime hydrate (MCCI)	10.86	12.50	7.62
Commercial hydrate (SATII)	10.88	12.54	7.58
<b>C. Hydrocarbon test</b>			
Carbide hydrate (MCCI)		-	negative
Lime hydrate (MCCI)		-	no test conducted
Commercial lime (SATII)		-	no test conducted

**Table 2. pH Readings of Subsurface Soils**

Lime material change *	initial pH	DAY / pH					pH
		3	6	9	12	15	
		pH units					
<b>Trial 1</b>							
Carbide hydrate (MCCI)	5.06	5.87	6.29	6.36	6.51	6.93	1.87
Lime hydrate (MCCI)	5.04	6.14	6.44	6.80	6.80	7.12	2.08
Commercial hydrate (SATII)	5.00	6.24	6.54	6.85	6.88	6.95	1.95
<b>Trial 2</b>							
Carbide hydrate (MCCI)	4.52	6.00	6.22	6.57	6.60	2.12	2.12
Lime hydrate (MCCI)	4.32	5.53	6.02	6.27	6.48	2.28	2.28
Commercial hydrate (SATII)	4.50	6.10	6.23	6.45	6.56	2.20	2.20

\* Final pH minus initial pH

**Table 3. Determination of Lime Requirement Value (Buffer Method)**

	Trial 1	Trial 2
Type of soil used	clay loam	clay loam
Basin area (m <sup>2</sup> )	0.25	0.25
Initial pH	5.06	4.52
Soil pH with buffer	7.45	7.35
Amount (kg) carbide hydrate to be used per hectare pond (based on table)	4400	6380
Amount (g) carbide hydrate applied to basin (A=0.25 m <sup>2</sup> )	110	160
Final pH of treated soil (below surface)	6.93	6.64

**Table 4. Lime requirements of pond soil (clay loam)**

soil pH	carbide hydrate (kg/ha)
3.5	13200
4.3	7810
4.5	6380
5.0	4840
5.5	3960
6.0	1870

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## STUDY II:

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# SURVIVAL OF THREE SELECTED AQUACULTURE SPECIES IN CARBIDE HYDRATE-TREATED SOILS UNDER LABORATORY CONDITIONS

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### Objective

**T**he purpose of Study II is to generate information on the tolerance levels of fry of sugpo (*Penaeus monodon*), tilapia (*Oreochromis niloticus*) and kitong (*Siganus guttatus*) fingerlings to carbide hydrate at different concentrations in order to find out if the dosage application established in Study I falls within the "safe" levels for these species. To achieve this end, short-term bioassays were conducted to evaluate the feeding and swimming activities and survival sequences of the test animals when held in seawater with fishpond soil substrates previously treated with carbide hydrate.

### Methodology

**Experimental Setup.** Three-liter capacity glass jars were used as culture containers in conducting the experiments for Study II. The experimental setup consisting of four treatments was prepared as follows:

Prior to the experiment, 48 units of these transparent and cylindrical glass jars were thoroughly cleaned and assigned to four treatments

(treatments A, B, C and D); each treatment was replicated twice. The first treatment (A) consisted of natural water as culture environment without a soil substrate. The second (B), third (C) and fourth (D) treatments consisted of seawater with 3cm deep of fishpond soil substrates. The soil substrates were treated with three different quantity levels of carbide hydrate from MCCI, Iligan City. The soil substrate for the second treatment was obtained from carbide hydrate-treated soil and contained an amount of carbide hydrate equivalent to the computed optimum lime requirement as established in Study 1,; the soil substrate for the remaining two treatments were treated at about 5% and 10% above the lime requirement. The additional amount of carbide hydrate for treatments two (B) to four (D) was applied on the surface of the soil substrate.

Into each jar was added 2.5 liters of filtered seawater (pH 7.9) to serve as culture medium for the test animals. The seawater in substrated treatments was allowed to equilibrate with the soil substrate within 24 hours. The culture water in the four treatments was neither changed nor added during the whole experimental period.

To maintain the desired dissolved oxygen level in the culture water, each jar was provided with one airstone connected with 3/16" dia. plastic hose to the outlet of the main source of compressed air. The flow of compressed air was regulated such that it created fine air bubbles for water oxygenation yet did not disturb the soil substrate.

**Test Animals.** Three culturable species were used as test animals, namely, sugpo (*Penaeus monodon*), tilapia (*Oreochromis nitolicus*) and kitong (*Sigamus guttatus*). The selection was based on the fact that these were aquaculture species widely cultured in earthen ponds for market production (Kungvankij and Chua, 1986; Guerrero, 1983; Duray, 1990). The popular bangus, *Chanos chanos*, and high-valued alimango, *Scylla serrata* (Angudong, 1983; Agbayani, et al., 1991) were excluded at the time because their seedstocks were highly seasonal and were not available when the study was conducted.

Each group of test animals were exposed to their corresponding treatments for a period of 96 hours, according to established procedures

(Ward and Parrish, 1982, Eaton, 1973). The test animals were monitored and observed as frequently as possible over the entire duration of the experiment. The ocular observations were focused on the swimming behavior, feeding activity, occurrence of mortality and final survival.

**Bioassay for Sugpo.** The bioassay for sugpo was conducted on February 13-17, 1994. Another test run was performed on February 28 to March 4, 1994. The culture jars were prepared as outlined above and each stocked with 10 species of sugpo fry. The stage of the sugpo fry obtained from the MSU Naawan Integrated Prawn Production Project (IPPP) was postlarva 20, the stocking age for seeding commercial prawn ponds. The fry were approximately of the same size and age since they came from a single spawning of one breeder. Throughout the experiment the sugpo fry were generously fed newly-hatched brine shrimp two times a day.

**Bioassay for Tilapia.** As in the case of sugpo, two test runs were completed for tilapia. But unlike the sugpo, the tilapia fingerlings used as seedstock were produced by different breeders and of varied sizes (Total length = 35 - 60mm; Body weight = 1 - 4gm). Tilapia is a freshwater fish but the fingerlings used in this study were produced at the MSU Wet laboratory from tilapia breeders that were acclimatized to pure seawater and, for a long time, maintained as captive broodstock in their adapted marine environment.

The same experimental conditions for sugpo was duplicated for tilapia bioassay. The first test run was conducted on February 28 to March 4, 1994; the second on March 9-13, 1994. Because of their size composition the stocking density for tilapia fingerling was reduced to 6 per experimental jar. The tilapia fingerlings were fed commercial finfish pellets twice daily.

**Bioassay for Kitong.** The replicated test runs to expose kitong to different experimental treatments described earlier were both conducted on March 9-13, 1994. The seedstock for kitong bioassay were taken from the batch of laboratory-reared fingerlings. The fingerlings were an experimental product of MSU research from the mixed offsprings of second generation captive kitong breeders which were repeatedly induced to spawn by intramuscular injection with homoplastic pituitary extract (HPE) and human chorionic gonadotrophin (HCG).

The size variation of kitong fingerlings was wider and the average size was much larger than that of tilapia fingerlings. In fact the smallest was 78mm and weighed 7g, while the biggest specimen was 115mm in length and 29g in weight. In order not to stretch the carrying capacity of the culture medium, the stocking density was limited to one per jar only. The commercial finfish pellet used for tilapia fingerlings was the same feed amply given in the morning and in the late afternoon to maintain the kitong fingerling for the duration of 96 hours.

## Results and Discussion

**Swimming and Feeding Activity.** The test animals generally exhibited normal swimming and feeding activity from the time of stocking to the termination of the experiments. Although there was no measurement done on their swimming activity, the test animals were mostly observed to be active and responsive. Furthermore, the test animals did not show lethargy and lack of appetite normally expected in aquatic animals that are held in stressful conditions except for one or two, at most three specimen in a few jars. The tilapia and the kitong fed and swam as they normally do in the water column. Similar observations were noted in the sugpo fry. Oftentimes, the sugpo were seem browsing on substrate surface or crawling on the side of the jars. But their feeding activity were clearly observed when they stayed afloat in the water column to catch brine shrimp nauplii that circulated with the aerated water medium. All the animals continuously fed voraciously on their main diet.

**Survival of Test Animals.** The tabulated results of the short-term bioassay are presented in Tables 1 to 6. On the average, the survival rates shown by the test animals were high in all treatments, with values ranging from 65 to 100 per cent. Even in the case of kitong, whose individual biomass could have been too much for long-term holding in their experimental containers, the survival outcome was quite satisfactory. But among the test animals, tilapia gave the highest rate.

The survival results obtained from two test runs for sugpo showed the lowest survival of 65 per cent. Although unintentional handling stress

could not be entirely discounted as a minor causal factor, the mortalities in the experiment were largely thought to be due to two factors, namely; accidental death, and hydrogen sulfide gas ( $H_2S$ ) poisoning. The presence of  $H_2S$  gas in the aquatic environment was indicated by a rotten chicken egg smell of the water and blackening of soil substrates.

**Accidental Mortality.** Sugpo normally jerks in the water column and even off and above the water surface from time to time. This behavior is commonly observed whether they are held in small containers, such as the experimental jars, or in commercial hatchery concrete tanks with volumes ranging from five to 40 metric tons. In the present experiment some sugpo flexed and became stuck on the side brim of the jar and air hose above the water surface. Those that flexed during in-between monitoring period and adhered for quite a time died of desiccation.

**$H_2S$  Gas Poisoning.** The dead sugpo retrieved from the surface of the soil substrate were newly molted sugpo and it was suspected that their death could have been caused by  $H_2S$  gas poisoning because they were all noted in jars where  $H_2S$  gas toxicity and the occurrence of  $H_2S$  gas poisoning was related to the physiology of molting in sugpo and other crustaceans (Mantel and Farmer, 1983). Molting is the only way by which a crustacean can grow and expand its body. The  $H_2S$  gas dissolved in water is toxic to the nerves and the site of attack is the nervous system of the sugpo or any other aquatic animal. In this experiment, the gas dissolved in the water could have entered the soft, weakened and fragile body of the newly-molted sugpo, which normally imbibes a large amount of water immediately after molting for its expanding body. Sugpo is sensitive to  $H_2S$  gas and its tolerance limit is only .004ppm at water pH value of 6-7 (Chiu, 1988).

The mortalities observed in the test runs for kitong also occurred in jars with  $H_2S$  gas formation. For this reason the death is likewise attributed to the gas poisoning. The formation of  $H_2S$  gas often occurs in less-oxygenated soils with very high organic load. When there is less oxygen, the decomposition of the organic matter in the soil mainly proceeds under anaerobic conditions from which  $H_2S$  is produced. In the experimental jars where  $H_2S$  formation was noticeable the aeration source was accidentally detached overnight and the dissolved oxygen in the water could have been depleted.

## Conclusion

This short-term bioassay has shown evidences that support the hypothesis that sugpo fry and tilapia and kitong fingerlings can survive under confinement in seawater and soil substrate treated with carbide hydrate. More importantly, the tests have confirmed that carbide hydrate, when used as neutralizing agent to raise the pH of acidic fishpond soil to desirable levels, has no adverse effect on the three aquaculture species. Furthermore, the results of the experiments also suggest that no other toxic materials are present in MCCI carbide hydrate used in the study.

## General Summary and Recommendation

The neutralizing capacity of carbide hydrate from MCCI, Iligan City, was tested in Study I to raise the pH of acidified fishpond soil in a laboratory experiment. Under laboratory conditions the carbide hydrate was found effective and comparable to commercially available liming substances in correcting the soil pH. Based on the result, the computed optimum lime requirement for soil with specific acidic pH was determined and specified. This specification of liming dosages can be useful for commercial fishpond application. On the other hand, the results from Study II of bioassay for sugpo, tilapia and kitong has established that carbide hydrate can be incorporated into soil substrate as liming material without causing harm or deleterious effect on the three culturable commercial species. It is also apparently shown in Study II that the MCCI carbidehydrate does not contain component that may be toxic to the three test animals.

The results from these two studies can help promote the commercial utilization of this erstwhile less useful by-product of acetylene production as alternative liming material for highly profitable fishpond operations. These laboratory findings, however, are nothing until they are put to use by the targeted ultimate beneficiaries who are the individual fishpond owners and entities involved in the fisheries industry, specifically, those in aquaculture production business. It is, therefore, our recommendation that the research on carbide hydrate be continued in commercial earthen pond operation to verify and pilot the laboratory findings and to serve as a

showcase for potential beneficiaries. For a start, we further recommend the use of sugpo. Sugpo is chosen for the following reasons. Firstly, sugpo commands a very high price both in domestic and international markets. Secondly, sugpo culture has an established technology for hatchery and grow-out production including pelletized feeds. Finally, culture facilities like earthen ponds owned by government and private entities are readily available in the region. Perhaps a special arrangement can be negotiated for the research use of their fishponds within a specified period of time.

### **Acknowledgment**

We are deeply indebted to the following for the completion of these studies: the MCCI, Iligan City, for financial support; the *S. guttatus* Group for the fingerlings of Kitong and Tilapia and finish pellets; the MSU Naawan IPPP for the sugpo fry and the brine shrimp nauplii; Jenis Amarga and Bebot Gaid for helping in sampling and preparation of samples for analysis; and Recot Roa and Nonon Mamauag for the illustration and bookbinding. The MSU Naawan and the MSU Naawan Foundation are gratefully appreciated for the research facilities and administrative support, respectively.

Table 1. Sugpo (*P. monodon*) Bioassay Test Run 1 - Feb. 13-17, 1994.

Number of Rearing Days						
Jar #	1	2	3	4	Final Count	Mean Survival
A1	10	1 inactive	1 dead		9	
A2	10				10	9.5
B1	10	2 inactive	2 dead		8	
B2	10	2 inactive 1 dead	2 dead	2 dead	5	6.5
C1	10	1 inactive	1 dead		9	
C2	10	1 inactive	1 dead		9	9.0
D1	10	1 dead	1 dead		8	
D2	10	2 inactive	2 dead	1 dead	7	7.5

Death - some due to attachment of sugpo to brim of jar or airhose and some due to molting.

Table 2. Sugpo (*P. monodon*) Bioassay Test Run 2 - Feb. 28 - Mar. 4, 1994.

Number of Rearing Days						
Jar #	1	2	3	4	Final Count	Mean Survival
A1	10	Some molting	3 dead		7	
A2	10	and weak			10	8.5
B1	10	Some molting	1 dead		9	
B2	10	and weak	2 dead	1 dead	7	8.0
C1	10	Some molting	2 dead	2 dead	6	
C2	10	and weak	1 dead	1 dead	8	7.0
D1	10	Some molting	2 dead		8	
D2	10	and weak	2 dead	1 dead	7	7.5

Death - some dead due to attachment of sugpo to brim of jar or airhose and some due to molting.

**Table 3. Tilapia (*O. niloticus*) Bioassay Test Run 1 - Feb. 28 - Mar. 4, 1994.**

Jar #	Number of Rearing Days				Final Count	Mean Survival
	1	2	3	4		
A1	6				6	
A2	6				6.0	
B1	6		1 dead		5	
B2	6		2 dead		4	4.5
C1	6				6	6.0
C2	6				6	
D1	6				6	
D2	6				6	

Death - some dead due to attachment of sugpo to brim of jar or airhose and some due to molting.

**Table 4. Tilapia (*O. niloticus*) Bioassay Test Run 2 - Mar. 9-13, 1994.**

Jar #	Number of Rearing Days				Final Count	Mean Survival
	1	2	3	4		
A1	6				6	
A2	6				6	
B1	6				6	
B2	6				6	4.5
C1	6				6	
C2	6				6	6.0
D1	6				6	
D2	6				6	6.0

Tilapia were fed with finish commercial pellets.

Tilapia Size and Weight Ranges:

Total Body Length - 35-60 mm, Body Weight - 1-4 gms.

Table 5. Kitong (*S. guttatus*) Bioassay Test Run 1 - March 9-13, 1994.

Jar #	Number of Rearing Days				Final Count	Mean. Survival
	1	2	3	4		
A1	1				1	
A2	1				1	1.0
B1	1				1	
B2	1				1	1.0
C1	1	died due to				
C2	1	weak aeration				0.0
D1	1				1	
D2	1				1	1.0

Table 6. Kitong (*S. guttatus*) Bioassay Test Run 2 - March 9-13, 1994.

Jar #	1		Mean Survival
A1	1		
A2	1		1.0
B1	1		
B2	1		1.0
C1	1		
C2	1		0.0
D1	1	died due to	
D2	1	weak aeration	1.0

Kitong were fed with commercial pellets.

Kitng Size and Weight Ranges:

Total Body Length - 78-115 mm

Weight - 7-29 gms.

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