PRELIMINARY ANALYSIS OF THE POTENTIALS OF DUCKWEED IN WATER SAFETY AND CLIMATE CHANGE (Food Security)

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"Coping with Copenhagen: Water, Waste, Energy, Health…"

RELATIONSHIP OF THE THEME &THE PRESENTATION

- Duckweed studies relates to Aquaculture Farming, and aquaculture is regarded as a response mechanism to climate change (under the LCDS).
- Studies relating to duckweed has enormous potential for agriculture and environment. (FAO, 1999)
- Duckweed technology will have a two-fold impact on environmental sustainability since it can reduce impacts (environmental, health, etc.) from polluted water by accumulating vital minerals and converting it to usable forms and secondly by aiding in food security by providing cheaper alternative food source for aquaculture, poultry & livestock; at a time when oceans and seas and land masses are threatened by climate change.
- Duckweed has other potentials for ecosystems.

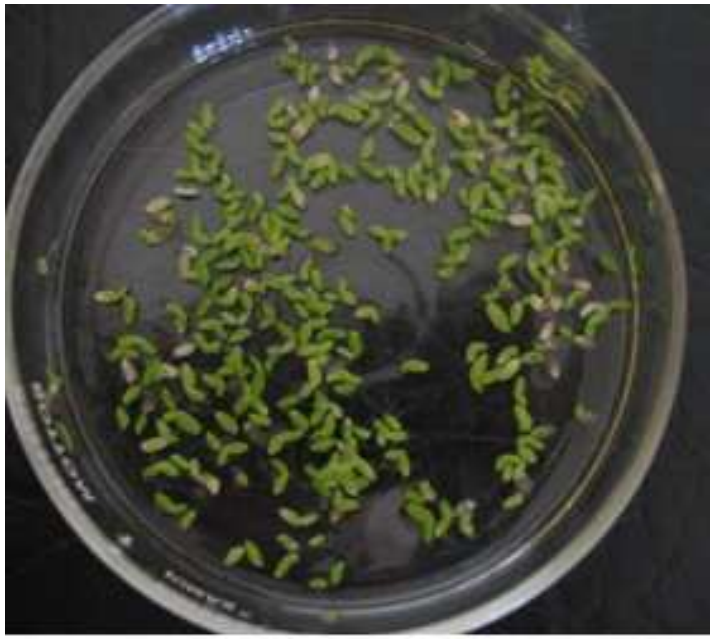
RATIONALE FOR RESEARCH

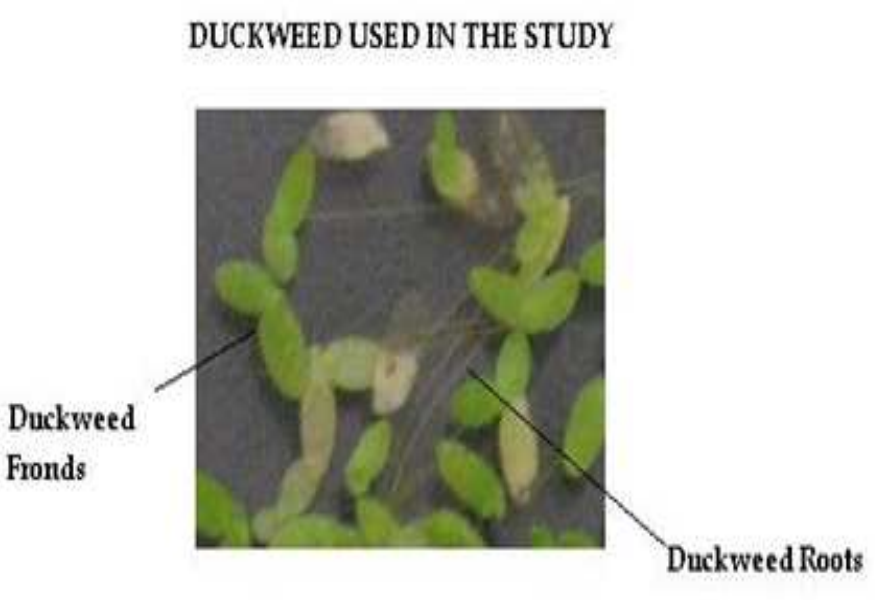
- In many parts of the world and especially in the Asian continent aquaculture is a heavily promoted activity and achieves significant economic gains. The use of "duckweed" as a feed source for aquaculture and livestock has also been advocated, with many success stories.
- Duckweed is a locally occurring species and that aquaculture farming and other livestock rearing are been encouraged; thus it offers a fair reason to investigate the potentials of duckweed usage on the local market. Therefore, the collection of baseline data for references should be undertaken, hence the research idea.

RATIONALE FOR RESEARCH

Duckweed Growth in Trenches

WHAT IS DUCKWEED?





❖ 4 genera, ~ 40 species are known world wide, most common species in Guyana is the *Lemna minor*

❖Concentrate minerals from polluted water such as that arising from sewage treatment facilities, intensive animal or crop processing or production industries.

❖Shows potentials as a feed source

ANATOMY & MORPHOLOGY OF *LEMNA*

- Duckweeds are diminutive, fragile, free floating aquatic monocotyledon perennial plants. Its size of approximately 1-15 mm, often occurs as a solid cover on the surface. All of the species have flattened minute, leaf like oval to round "fronds" from about 1mm to less than 1cm across. *Leaves and stem are usually merged into a common structure called frond/thallus.*
- Some species (Lemna) develop root-like structures, usually one connecting to the underside of the frond which can assist with stabilization of the plant or the absorption of nutrients. *Usually absorption occurs via the fronds.*
- Duckweed reproduces at twice the rate as other vascular plants, hence the fronds and ultimately the biomass doubles every 1-2 days.

BACKGROUND TO THE STUDY

- National Aquaculture Association of Guyana (NAAG) thus identifies the research priorities for the production of duckweed as fish food.
- IADB has funded a project (GY-M 1010;ATN/ME-10884-GY) aimed at "increasing the productivity of small farmers by integrating duckweed production with fish farming". This project is being executed by the Institute of Private Enterprise Development (IPED), to the tune of USD125, 672.00, through Integrated Farming System.
- Worldwide baseline data and enhanced research is extensive and continuous especially in using duckweed as a food source grown on polluted water.
- Baseline data in Guyana is minimal or even lacking in many instances.

DUCKWEED FARMING IN GUYANA

- Duckweed farming is extended to all ten (10) Administrative Regions of Guyana, through the Integrated Farming System Model. (29 demonstration sites)
- Integrated farming which includes growing duckweed and feeding it to fish or poultry is practiced by one hundred and thirteen (113)farmers. April, 2010 IPED. (Feed duckweed to Fish or Poultry/Livestock)
- A draft training manual on "Integrated Farming-Bio-digester, Aquaculture & Duckweed" is being prepared by IPED and will include the practical experiences. (EPA Guyana & GEA expressed interest in bio-digesters as alternative energy source &as treatment for pig waste, hence energy source respectively.)

Source IPED April , 2010

DUCKWEED

Earthen Duckweed Pond

Concrete Duckweed Pond

GROWTH CONDITIONS & NUTRITIVE VALUE OF *LEMNA*

- Calculated crude protein content of duckweed ~25%
- Duckweed grown in Guyana is approximately 97.5% water and compared well with 86-97% (Landolt & Kandler 1987 and 92-94% (Leng R. A. et al. 1995).
- Duckweed survives between pH 5-9, but grows best over pH 6.5-7.5 (Leng R. A. et al. 1995). Local samples thrived at pH 7.58 on average.
- Duckweeds grow at water temperatures between 6 and 33° C. Growth rate increases with water temperature, but there is an upper limit of water temperature around 30° C when growth slows and at higher temperature ceases..
- Duckweed is made up of metabolically active cells, with little structural fiber, hence their tissue contain twice the protein, fat, nitrogen & phosphorus as other vascular plants.

GROWTH & NUTRITIVE VALUE OF *LEMNA*

- Duckweed grow with only requirements for minerals particularly nitrogen, phosphorus and potassium and utilizing solar energy to synthesize biomass. They have the ability to concentrate trace elements from dilute sources.
- Many duckweed species have protein content in the range 15-45%, depending on nitrogen supply, with a balanced distribution of amino acids.

- Duckweed species contained favourable distribution of plant minerals , compared with referenced information.

Macro Nutrient	Average % (Landolt & Kandler, 1987)	Average % (Ramjeet-Samad, 2009)
Nitrogen (N)	0.8---7.8	3.8
Phosphorus (P)	0.03---2.8	0.88
Potassium (K)	0.03---7.0	4.88
Macro Nutrient	**Average % (Landolt & Kandler, 1987)**	**Average% (Ramjeet-Samad, 2009)**
Calcium (Ca)	0.18---4.5	5.38
Magnesium (Mg)	0.04---2.8	0.58

- However calcium values exceeds acceptable values suggesting the probable presence of calcium oxalate crystals, which is neither a nutrient nor a beneficial source of calcium.

- Water quality supports and influences the chemical composition of duckweed tissue and also the kind of species particular to locations. The distribution of minerals in the water samples surpassed the referenced data, however Ca & Mg occurred within the range of referenced data value compares well with the referenced data.

Description/Quantity of	TKN	P	K	Mg	Ca
Basic Minerals	mg/L	mg/L	mg/L	mg/L	mg/L
Average	24.38	7.67	35.63	46.30	24.34
Range (Landolt & Kandler, 1987)	0.02-10	0.03-2	1.0-30	1.0-80	0.5-50

- As a result of climate changes water bodies that can supports plant growth (duckweed) may become saline due intrusion from flooding etc. However, duckweed has the ability to withstand or tolerate some degree of salinity , but not grow in salt marshes.

- All members of the duckweed family have the ability to concentrate heavy metals. However the concentrations are usually in very low concentrations. Many reports indicate that at high levels the health and growth of the duckweed is inhibited, but at the usual low concentrations can become a useful trace mineral for fish and livestock. In growing duckweed for commercial purposes the water quality should therefore be monitored, despite the fact that duckweed grows in polluted waters.

Elements	**%**	**%**
	(Landolt & Kandler, 1987)	**(Ramjeet-Samad, 2009)**
Aluminum (Al)	0.000---11.4	0.2
Copper (Cu)	$0.2x10^{-3}$---3.2	0.18
Iron (Fe)	0.007---3.2	0.57
Manganese (Mn)	0.003---6.4	0.39
Sodium (Na)	0.03---1.3	0.2
Lead (Pb)	**$0.2x10^{-4}$---0.02**	**0.07**
Zinc (Zn)	0.004---0.14	0.03

ECOLOGICAL RELATIONSHIPS & OTHER CONSIDERATIONS FOR DUCKWEED FARMING

- Duckweed as an aquatic species serves as an essential link in the aquatic food chain.
- Duckweed growth shades the water below and reduces the growth of algae.
- Since duckweed can grow on polluted water and absorb mineral elements it is useful in nutrient removal and bioremediation schemes.
- Within recent times there is accumulating evidence that suggests that duckweed release compounds that have insecticidal properties particular to the larva of mosquitoes; hence it has implications for mosquito in malaria affected areas.

CONCLUSIONS

- Duckweed ecology is important because of the promising physiological characteristics of the species.
- Locally occurring duckweed shows similar characteristics as those of referenced sources.
- The conditions for growth and utilization of this species are ideal.
- As a result of climate changes duckweed should be investigated as an opportunity crop, hence alternative feed source in agriculture.
- Other ecological considerations be taken into account.

RECOMMENDATIONS

This research therefore recommends the following:

- That further validation research be conducted on local duckweed species especially for the baseline data and comparing this to referenced data.
- That duckweed be investigated as an "opportunity crop", hence, an alternative feed source for aquaculture and other livestock (poultry).
- That the other ecological considerations mentioned earlier be investigated, especially for the suppression of algal growth and insecticidal properties on mosquito be investigated for locally occurring duckweed species.

THANK YOU