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Can kelp extract (KELPAK®) be useful in seaweed mariculture?

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Abstract

The addition of low concentrations of commercial kelp extract (*Ecklonia maxima*: Kelpak®) in addition to fertiliser has proven to be beneficial in agriculture. It triggers rooting in field crops, increases yields and has other useful effects, such as parasite reduction. Its efficacy has been attributed to the fact that Kelpak® is produced by a cold process, and is a high auxin/low cytokinin product. The aim of this study was to investigate if seaweeds (which do not have a root system) grown in culture systems, would benefit from the addition of Kelpak® or a combination of Kelpak® and fertilizer. A preliminary laboratory experiment was carried out by growing excised 15 mm tips of the red alga *Gracilaria gracilis* in culture dishes containing Provasoli Enriched Seawater medium to which various concentrations of Kelpak® were added. *Gracilaria* tips in some of the Kelpak® treatments (1:2500; 1:1000; 1:500) grew significantly better than the control. Further experiments were carried out on a pilot commercial scale at Jacobsbaai Sea Products Ltd. on the South African west coast. *Ulva lactuca* was grown in effluent from fish (turbot) culture, with additions of 1:5000, 1:2500 and 1:500 concentrations of Kelpak® once a week. The intermediate Kelpak® concentration (1:2500) produced the highest growth of *Ulva* in the turbot water, while the highest Kelpak® concentration (1:500) inhibited *Ulva* growth. In another *Ulva* experiment, various combinations of aquaculture effluent water, commercial fertiliser and Kelpak® at 1:2500 were used. Best growth of *Ulva* was obtained in turbot water containing both fertiliser and Kelpak®. The results suggest that Kelpak® could be useful in commercial seaweed mariculture operations.

Introduction

The use of seaweed extracts as soil drenches and foliar sprays on agricultural plants is increasing, even though the literature on seaweed extracts is contradictory. Some studies suggest that seaweed extracts have no effect on plant growth (Verkleij, 1992). In contrast, documented studies on a commercial extract of the brown kelp *Ecklonia maxima* (Kelpak®: Featonby-Smith & van Staden, 1983, 1987; Crouch, 1990) have reported that these seaweed extracts improve the growth rates and yields of crops, as well as preventing pests and improving the overall quality of the product. Many of the physiological responses shown by crop plants treated with seaweed concentrates are thought to be due to cytokinins and auxins, a number of which have been demonstrated to occur in Kelpak® (Stirk & van Staden, 1996, 2004; Crouch et al., 1992). The beneficial effects of this product have been attributed to the plant hormone content of the extract. Since seaweed concentrates are applied in small doses, the active compounds in these concentrates need to be effective at low concentrations. Many studies have looked at the effect of applying plant growth regulators (PGR), such as auxins and gibberellins, on seaweed growth (review in Lobban & Harrison, 1997; Yokoya et al., 1999, 2003).

Kelpak® is a commercially available seaweed extract and is marketed as a plant growth stimulator due to its hormonal content and not its nutrient content

(Featonby-Smith & van Staden, 1983, 1987). It is manufactured by Kelp Products (Pty) Ltd. in Simons Town, South Africa, from epiphyte-free fronds and stipes of the brown alga *Ecklonia maxima* (Osbeck) Papenfuss, using a cold cell-burst process (Verkleij, 1992; Stirk & van Staden, 1996, 2004; Stirk et al., 2004). This process excludes the use of heat, chemicals or dehydration that could affect some organic components of the concentrate (Verkleij, 1992).

The aim of this paper was to test the effects of Kelpak on growth of seaweeds in culture. This was initially done in controlled conditions in the laboratory, using excised tips of *Gracilaria*, which are easy to grow and measure. Subsequently, pilot commercial-scale experiments were carried out to test the effects of the kelp extract on the growth of *Ulva* in tank culture on a commercial abalone/fish farm. *Ulva* was chosen for this, as we have considerable experience in growing *Ulva* in these systems as potential feed for abalone. Nutrient content of the cultured *Ulva* was also measured, with regard to its use as abalone feed. Experiments on *Gracilaria* growth in these systems were not as successful as *Ulva*, particularly due to low temperatures on the farm, and these are not presented.

Björnsäter and Wheeler (1990) and De Busk et al. (1986) showed that additions of fertilizer to nutrient-depleted water significantly increased Specific Growth Rate (SGR) of *Ulva*. Species of *Ulva* have been successfully grown in effluent water (abalone, fish and human) and SGR's are significantly higher compared to *Ulva* sp. grown in seawater (Ryther et al., 1975; Vandermeulen & Gordin, 1990; Cohen & Neori, 1991; Neori et al., 1991; Neori, 1996; Jimenez del Rio et al., 1996; Shpigel et al., 1997; Goldberg et al., 1998). As some land plants grown with fertilizer and Kelpak®, showed significant increases in SGR (Featonby-Smith & van Staden, 1983, 1987; Crouch, 1990), the authors wished to test this observation for seaweeds using an effluent aquaculture medium as the source of nutrients for the seaweeds.

Materials and methods

Four different experiments were run in order to investigate the effects of Kelpak® on cultivated algae. Kelpak® adds only a very small amount of nutrients as a proportion of the total nutrients applied to the seaweeds at these low concentrations: it has an N: P ratio in mg N/P per g DW of Kelpak® of 55.98: 49.15 ($\pm$ 0.01; $n = 6$) (Robertson-Andersson, 2004). This was tested in the first instance in the laboratory, using excised tips of *Gracilaria*, selected for ease of growth and measurement, followed by measurements of growth rates of *Ulva* in an existing experimental system on a commercial abalone farm. Growth of *Ulva* was tested in combinations of seawater, abalone and turbot effluent, with various concentrations of Kelpak®, with and without additional fertilization. Nitrogen content of the seaweed thalli was measured as a physiological parameter of seaweed health.

Laboratory experiments

The material was collected one day prior to the start of the experiment. *Gracilaria gracilis* (Stackhouse) Steentoft, Irvine *et* Farnham was collected from Saldanha Bay on the South African west coast, and was washed with running fresh water and sterile seawater and brushed with a paint brush to eliminate contaminants. The darkest thallus fragments were selected and 15 mm unbranched apical segments cut.

One-third strength standard Provasoli Enriched Seawater medium (PES) was prepared according to a standard recipe (Starr & Zeikos, 1987). The Kelpak® treatments were; 1:100, 1:250, 1:500, 1:1000, 1:2500, and 1:5000 added to one third strength PES. The control consisted of one-third strength PES medium with no Kelpak® added. The culture medium was changed every 2 days. The experiments were carried out at 15 °C temperature with an irradiance 50–80 μmol photons m^{-2} s^{-1} provided by cool white fluorescent tubes and a photoperiod of 16 h. (light) : 8 h. (dark). Culture vessels were 200 cm^3 crystallizing dishes to which 200 mL of PES was added as well as five 15 mm apical segments of *Gracilaria gracilis.* There were four replicates for each treatment. The flasks were moved within the experimental setup on a daily basis to ensure a uniform environment for all flasks. The initial, and on completion of the experiment, final biomass (in fresh weight) was measured, from which the SGR could be calculated using the following formula (Evans, 1972) and calculated as: $\mathrm{SGR} = [\ln (W_t/W_0)]/(t_t - t_0)$

Where W_0 and W_t are initial and final wet weights (wwt) in grams and t_0 and t_t are initial and final times in days respectively.

Number of branches per tip was measured for each treatment at the end of the experiment.

Pilot commercial scale experiments

The commercial scale experiments were run on the Jacobsbaai Sea Products (JSP) Aquaculture Farm