Application of the condition factor in the production of African Sharptooth Catfish *Clarias gariepinus*

Assignment presented in partial fulfilment of the requirements for the degree Master of Philosophy in Livestock Industry Management: Aquaculture, at the University of Stellenbosch

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Declaration

I the undersigned hereby declare that the work contained in this assignment is my own work and has not previously in its entirely or in part been submitted at any University for a degree.

Signature ______________________ Date _____10 March 2005_

Abstract

In recent years there has been a renewed interest in the commercial culture of African Sharptooth Catfish. Its robust characteristics and its air breathing capabilities makes the African catfish a good candidate for culture in intensive recirculating systems. In light of the size variation in offspring spawned from undomesticated fish, that may eventually increase cannibalism, suitable methods for the quantification of some production performance parameters such as growth and health measurements need to be established for application in intensive catfish culture. In fish the condition factor (CF) reflects information on the physiological state of the fish in relation to its welfare. This factor is expressed as Fulton's condition index, or the *K-factor*.

African Sharptooth Catfish fry with average weight of 1.9g ± 0.7867 and average length of 59.375mm ±8.812 were equally allocated into ten 1000L-recirculating tanks. The fish were fed a commercial feed to apparent saturation at a frequency of 5 times per day. Sixteen fish were sampled out of each treatment. Weight (g) and length (mm) of each fish were recorded every seven days over a trial period of 175 days from which Fulton's condition index *K* was calculated. Results were analysed for significant differences using one-way ANOVA and Tukey's pair wise comparison test for the various parameters.

Growth parameters ($a = -5.083$, $b = 3.004$, $R^2 = 99.4\%$) derived from the logarithmic relationship between body weight (*W*) and standard length (*L*) indicated an isometric growth through the duration of the trail. No significant differences ($P>0.05$) in condition factors between treatments were found at the beginning of the trail. Significant differences ($P<0.05$) were found at the end of the trail for weight between ponds and condition factor between treatments. No significant difference ($P> 0.05$) between length and treatments were found at the end of the trial.

Mean condition factor was 0.856 ± 0.187. By using this information on condition factor for African catfish a *K-factor* calculation chart for African catfish could be calculated, to be used as a practical measurement tool to measure performance goals on catfish farms.

Uittreksel

Die Skerptand baber *Clarias gariepinus* het ‘n hernuwe belangstelling in die kommersiële produksie van hierdie vis spesie herleef. Hul geharde karakter einskappe en hul vermoë om suurstof uit die atmosfeer te gebruik, maak hierdie vis ‘n ideale kandidaat vir produksie in intensiewe hersirkulasie sisteme. Gepaste metodes vir die kwantifisering van sommige produksie parameters, soos groei en gesondheids vlakke, moet geimplementeer word, aangesien grootte verskille onder jonger visse tot verhoogde kannibalisme kan lei. In vis reflekteer die kondisie faktor die algehele welstand van die vis. Hierdie faktor word uitgedruk as Fulton se *K* waarde.

Jong Skerptand babers met ‘n gemiddelde gewig van 1.9g ± 0.7867 en ‘n gemiddelde lengte van 59.375mm ± 8.812 was gelykop verdeel in tien 1000L hersirklasie tenke. Die vis was ‘n kommersiële dieet gevoer tot oënskynlike versadiging, vyf keer per dag. Steekproewe van sestien visse uit elke behandeling was op ‘n weeklikse basis geneem. Gewig (g) en lengte (mm) van elke individuele vis was weekliks gedokumenteer oor die proef periode van 175 dae. Vanuit hierdie data is Fulton se kondisie faktor bepaal terwyl die betekenisvolheid van waargenome verskille bepaal is aan die hand van ‘n eenrigting Analitiese van Variasie asook deur middel van Tukey se paarwyse vergelykingings metode. Groei parameters (a = -5.083, b = 3.004, R^2 = 99.4%) was verkry van die logaritmiese verhouding tussen gewig (*W*) en lengte (*L*), dui n isometriese groei aan. Geen betekenisvolle verskille ($P>0.05$) vir kondisie was aan die begin van die proef gevind nie, maar betekenisvolle verskille ($P<0.05$) was wel aan die einde van die proef gevind vir beide gewig en kondisie. Geen betekenisvolle verskille ($P>0.05$) was vir lengte tussen behandelings gevind aan die aanvang en einde van die proef nie. Gemiddelde kondisie factor gedurende hierdie proef was 0.856 ± 0.187. Deur gebruik te maak van hierdie data is ‘n analitiese model opgestel vir Skerptand babers, om sodoende ‘n praktiese model beskikbaar te stel vir die meet van prestasie doelwitte op baber plase.

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List of Abbreviations

BOD	Biological Oxygen Demand
CF	Condition Factor
GMP	Good Manufacturing Practice
Hb	Haemoglobin
Ht	Haematicrit
SOP	Standard Operating Procedures
TTP	Total Plasma Protein

Chapter 1

LITERATURE REVIEW

1.1. Introduction

One of the most important characteristics of the African Sharptooth catfish is their ability to exploit a wide variety of both animal and plant protein, and their ability to withstand diverse environmental conditions and high stocking densities. One of the reasons for them being able to withstand harsh environmental conditions is the fact that they can utilise oxygen from the air. These characteristics make the African catfish a good candidate for the culture in intensive recirculating systems. The success of such a system lies in the management practices of the farm manager and the characteristics of the African catfish make these management practices easier. However, the African catfish is an aggressive predator and cannibalism is a frequent occurrence. To minimise cannibalism and aggressive attacks the farm manager needs to implement good managerial practices. The manager of such a venture also needs to understand the basic principles of recirculating systems as well as the requirements of the species chosen (Losordo, 1998; McGee, 2000), and he/she will need suitable methods to measure production parameters such as growth and the well-being of the fish.

Due to the increase of production cost in a recirculating system, especially the increase in feed costs; one must be able to market and sell the fish as a health product in order to select the higher income groups. To market fish to the higher income groups the fish must be of good quality and in a very good condition. The flesh must have the right colour, texture, taste and smell. To get a good conditioned fish with the right colour flesh, no off flavours and smells, it is imperative to give the fish all the nutritional requirements the fish needs, as well as the optimum environmental conditions.

It is thus in the aquaculturist best interest if he/she knows and understand some of the major factors that may influence the condition and overall well-being of the catfish in a intensive recirculating system.

1.2. Factors influencing the condition of fish

Feeding and nutrition, water qualities, age and sex, stress, stocking densities and environmental conditions are factors influencing the condition of fish. The condition of fish, especially when sold whole, is not just its body volume but also the condition of the skin and fins. It is thus important that the fish is also in good health. In recirculating systems most of these factors are easier to manage than in extensive system where there are less control over certain environmental conditions. However, in a recirculating system the stocking densities are usually higher per m^3. With these higher stocking densities together with more intensive feeding leads to higher risk to certain factors that could influence the condition of catfish.

Recirculating systems are mechanically and biologically complex and component failures, poor water quality, stress, disease and off flavour are common problems in a poorly managed and poorly designed recirculating system (Masser 1999). For optimum condition critical environmental parameters in a recirculating systems culture water include, dissolved oxygen, unionised ammonia, nitrite-nitrogen, nitrate, carbon dioxide, pH and alkalinity.

1.2.1. Feeding and Nutrition

The nutritional requirements of the fish as well as the water quality are important in assessing the feeding management in a recirculating system to achieve optimum growth and condition. Since there is no natural food in a recirculating system fish in these systems require high quality feeds which will provide optimum nutritional requirements to attain good growth and good condition (Van Gorder, 1994). Fish feed for such a system must be made to the requirements of the specie being cultured, and should contain as little dust particles as possible.

In an extensive operation the availability of natural food are available in abundance. The stocking densities in this system are also much lower than in an intensive system. This means that the need for artificial diets is lower than in an intensive recirculating system. In the intensive recirculating system it is the exact opposite and a good quality feed must be produced to supply all the nutritional requirements the fish needs. In an intensive farming operation a better feeding management strategy must be put in place (Riche, 2003). Nutritional requirements are influenced by different factors such as; species, sex of the fish, age, mass, stocking density, desired carcass composition, nutritional factors and environmental factors. Uys, (1988) reported that best growth rates and feed conversion ratios for juveniles and sub-adult catfish are achieved by a diet consisting of 38% to 42% crude protein and an energy level of 12 kJ g^{-1}. The protein requirement as well as the energy requirement of catfish is important to have a good nutritional and energy balance in the fish. If this balance is in equilibrium then the fish will have optimum growth rates and a good condition.

Figure 1.1 gives an illustration of how energy and nutrition are allocated by a fish (Lloyd, 1992).

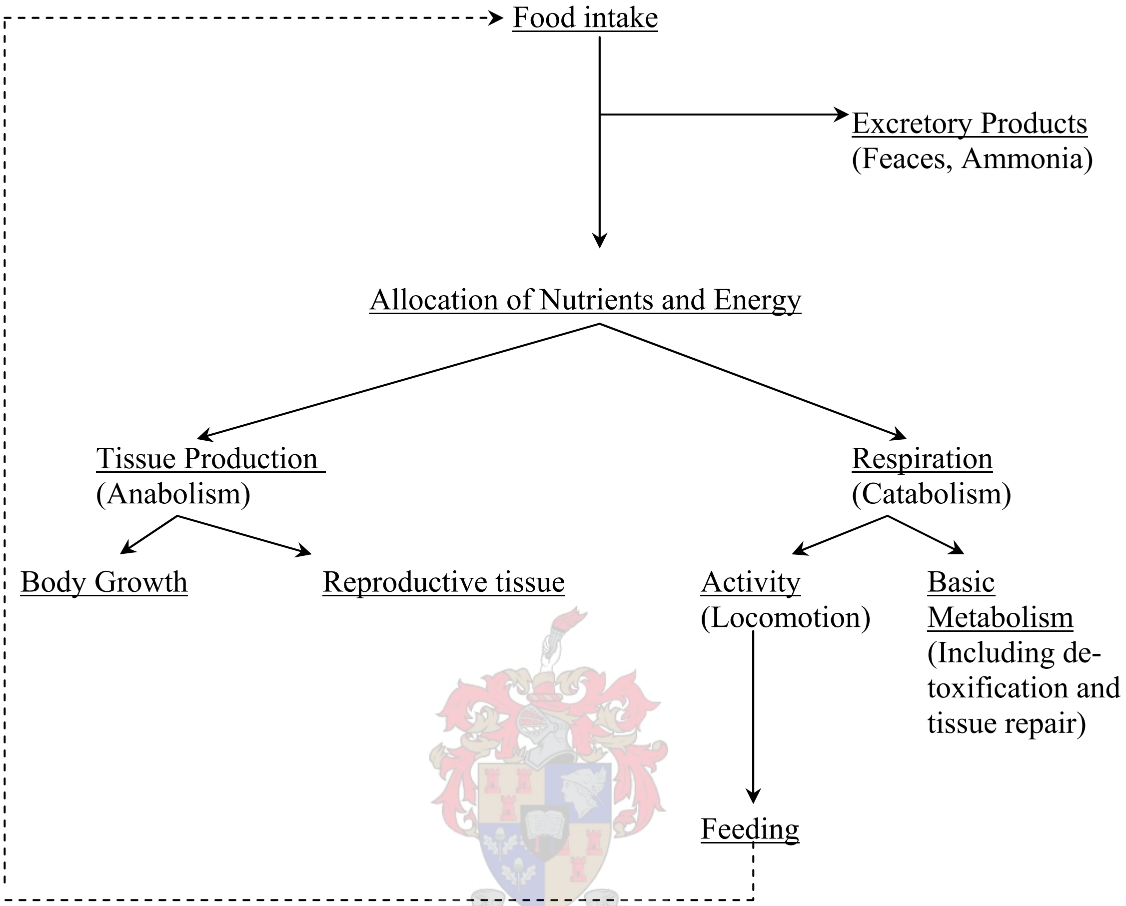

Figure 1.1. Energy and nutritional balance in fish (Lloyd, 1992).

When fish are, eating a certain amount of the feed ingested will be excreted as waste products. Thus the primary source of pollution in an aquaculture venture is feed. The artificial enrichment of water often results in noxious algae blooms or excessive growth of higher plants. This is called eutrophication. Phosphorus and nitrogen primarily originate from feed and are of great concern due to their role in nutrient enrichment, hence eutrophication. In fish, about 30% feed nitrogen and phosphorus are retained (Figure 2.2), (Ramseyer L.J.).

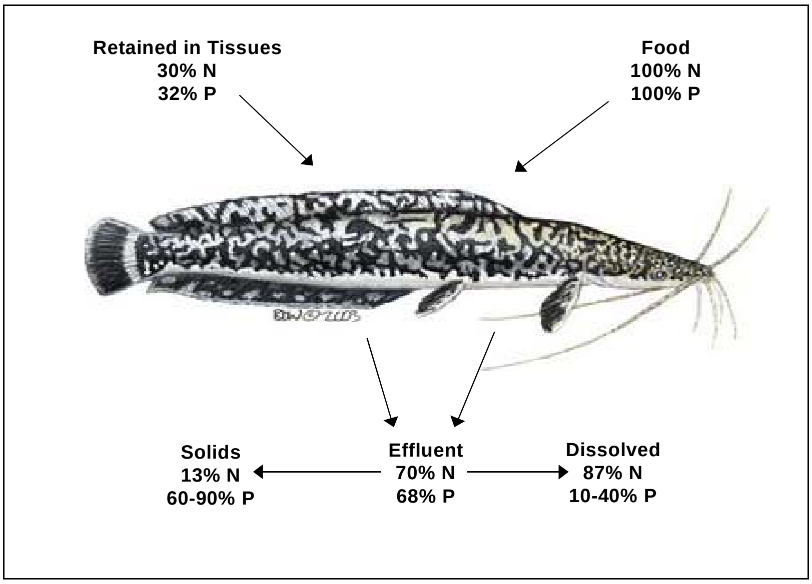

Figure 1.2. Fate of nitrogen and phosphorus in feed (Adapted from Swann, 2004)

Commercial feeds are often formulated to contain a slightly higher level of a nutrient than is required by the species. The extra nutrients serve as a safety margin to ensure that the requirements for maximum growth are met, because few of the feed ingredients are completely digested and or absorbed. These safety margins contribute to the production of wastes in a fish farm (Ramseyer, 2004).

An excess of amino acids in the feed will contribute to an increase in nitrogenous waste excretion by the fish (Ramseyer, 2004). Formulating feed that meet the specific species requirements and feeding methods can reduce excess nitrogen wastes in the water. Most nitrogen is excreted in a dissolved form, and management practices to control solids are not effective in reducing nitrogen. Balancing the amino acid profiles of the species requirements and avoiding overfeeding are the best ways to minimise the excretion of nitrogen (Ramseyer, 2004). This means that feed protein balance, digestibility and quantity is important factors in controlling nitrogen concentrations in the effluent.

Increasing temperature affect the nitrogen excretion by increasing voluntary feed intake and food movement through the gut while decreasing the nutrient utilisation. This is a problem if feeding *ad libitum* or using automatic feeders. Fish will usually eat more than required for optimum growth and nutrient utilisation. This will mean an increase of effluent nitrogen. It is clear that when a well balanced feed is used, the energy and nutritional balance in equilibrium is and as little waste as possible will get excreted, and as a result one can achieve good growth and condition in the catfish.

1.2.2. Water quality

Water quality is one of the most important factors influencing the growth and condition of catfish. African catfish will survive in poor environmental conditions, but this does not mean the fish will grow optimally. To achieve optimum growth and condition it is important to maintain optimum water qualities throughout the production cycle (Masser, 1999). Some of the most important components of water quality affecting growth and condition are, ammonia, nitrite, dissolved oxygen, suspended solids and temperature.

1.2.2.1. Ammonia

Feeding rate, feed composition, fish metabolic rate and the quantity of wasted feed affect the water quality in a recirculating system (Losordo, 1998). Ammonia is the result of the digestion of protein, and is proportional to the feeding levels in the system. In most recirculating systems ammonia is removed by a two-step process of biological filtration. Adequate surface area for the growth of the bacteria is needed to meet the loading capacity of a system (Wheaton. 1994). This process of ammonia removal is called nitrification, and is the oxidation of ammonia to nitrate with nitrite as the intermediate product. Nitrifying bacteria are called *chemosynthetic autotrophs* or *chemolithotrophs.* These autotrophic bacteria receive their energy from inorganic compounds. Organic compounds serve as an energy source for hetrotrophic bacteria. Of the autrotrophs, *Nitrosomonas sp.* is the major species in ammonia oxidation and *Nitrobacter* for the oxygenation of nitrite to nitrate (Wheaton, 1994). These processes require oxygen and the basic chemical conversions occurring in nitrification is shown in equations 1.1 and 1.2 (Wheaton, 1994).

$$NH_4^+ + 1.5O_2 \rightarrow 2H^+ + H_2O + NO_2^- \qquad (1.1)$$

$$NO_2^- + 0.5O_2 \rightarrow NO_3^- \qquad (1.2)$$

Through these conversions one can see that nitrification require oxygen, produce nitrite as an intermediate product and hydrogen ions, thus lowering the pH (Wheaton, 1994).

The filter will need a period in time to adjust to the load put on the filter by the stocking densities of fish and their feeding rate. This period can be several weeks and Fred Wheaton suggested that filter break-in usually requires 30 – 60 days. Filter start-up is described in Figure 1.3 and is important for a manager to understand due to the impacts it might have on the condition of fish would system failure occur (Wheaton, 1994; Wheaton, 2003). The importance of filter start-up can be illustrated by Prinsloo *et al* (1999), where their initial data on catfish growth were influenced by catfish mortalities, which occurred during the third week of their investigation when the nitrogen removal efficiency of the biofiltration had not yet become functional (Prinsloo, 1999).

As hetrotrophs convert organic compounds to inorganic compounds, the ammonia concentration will continue to rise until a sufficient *Nitrosomonas* population is established to oxidise ammonia. At this point the population of bacteria (*Nitrosomonas*) is big enough that ammonia consumption exceeds ammonia production. At this stage ammonia concentrations falls to a low level and the level of nitrite rise due to its production by *Nitrosomonas* as a by product. Due to rising levels of nitrite, *Nitrobacter* populations start to grow and consume the nitrite and form nitrate. Once the nitrite falls to a low level, the filter is considered to be started-up or broken-in. The nitrate will keep rising in the system unless it is removed by plants or water exchanges (Wheaton, 1994; Wheaton, 2003; Masser, 1999).

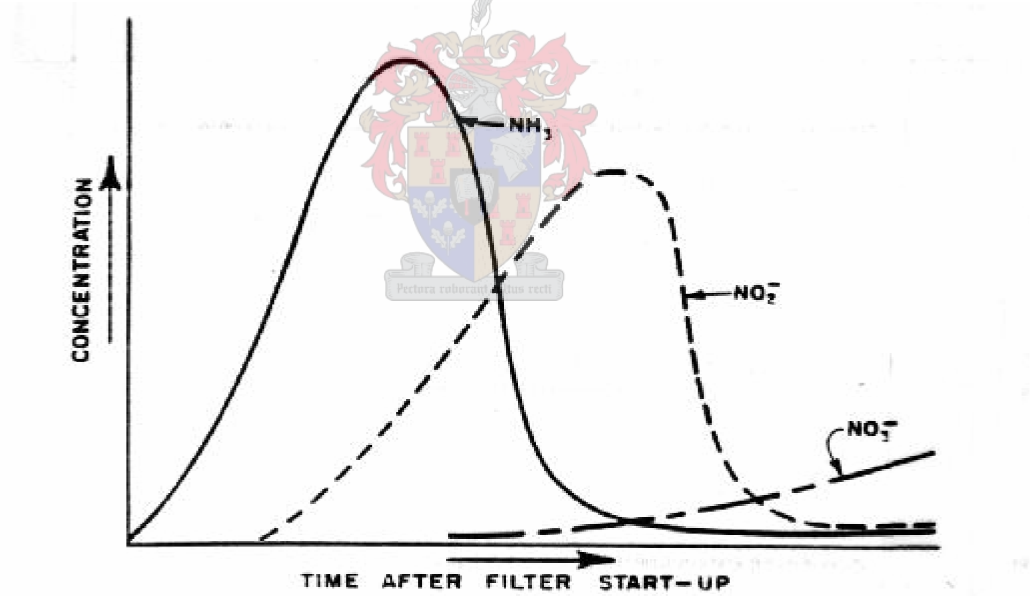

Figure 1.3. Biofilter start-up (Wheaton, 2003)

Filter start-up consists of introducing live animals into the system in small quantities so ammonia increases gradually. Animal load is increased gradually giving the filter time to equilibrate. The filter is brought to full loading capacity gradually so shock loading does not cause system failure.

High ammonia (NH_3) levels affect osmoregulation and reduce internal iron concentrations. This will cause the fish to use a large amount of energy to restore its osmoregulation, since this is such an important factor in the fish's well-being. Ammonia also cause swelling and inflammation of the gills and other tissues, damages skin and eyes, reduce oxygen transport in the blood, swelling and diminishing of red blood cells, decrease oxygen consumption of tissues and thus increasing susceptibility to disease. Gill hyperplasia is a common effect of ammonia. This is the swelling of gill filaments and the filaments tend to clump together. Gill hyperplasia will therefore reduce the transfer capacity of oxygen from the water to the blood and in return reduce the excretion of waste products like ammonia and CO_2 (Roets, 1997). The fish will need more energy to meet the oxygen levels required and to secrete waste products. In this situation the energy and nutrition balance (figure 1.1) will shift and, more energy will be spend to repair the gills, transfer of oxygen over gills (increase in respiration), and excretion of ammonia and CO_2 levels to the water. This means there will be less energy for growth and, since eating levels in catfish and other species tend to decrease or even stop means the fish needs to use its fat reserves and muscle protein to try and repair its balance. This will lead to a decrease in growth and weight. Since the length cannot decrease the condition of the catfish will decrease significantly (Lloyd, 1992).

1.2.2.2. Nitrite

In equation 1.1 and 1.2 one can see that nitrite is the intermediate product of nitrification. Nitrite is toxic at low levels and damage the gills and oxidise the iron (Fe^{2+}) in haemoglobin to Fe^{3+} and is called metheamoglobin, which is not an effective oxygen carrier. This gives the blood a brown colour, hence the term brown blood disease (Roets,1997).

Continued absorption of nitrite can lead to tissue hypoxia and cyanosis (Ceronio, 1995). Fish with this nitrite poisoning will become inactive and will stop eating due to the low levels of oxygen carrying capacity, one will also observe fish spending more time gasping at the surface of water. In this instance the shift in the energy balance occur to increase ventilation and to repair damage tissue as well as the balance within the fish. This will lead to a decrease in growth and condition and in acute situation death (Roets, 1997)

1.2.2.3. Dissolved Oxygen

Dissolved oxygen levels should be maintained above 60% of saturation or above 5 mg/L for most warm water culture systems (Watten, 1994). If the dissolved oxygen in the system is not at the correct levels then this will directly influence the feeding levels of the fish, as well as the function of the biofilter. The nitrification efficiency of the filter bacteria becomes inadequate below 2 mg/L, with a filter failure as an result. Hence, an increase in ammonia and nitrite as a result. The lowest level for the fish is specie dependent (Watten, 1994). Since the African catfish is airbreathers these levels is not so critical. However, under high stocking densities some catfish will have to work harder to reach the water surface in order to get sufficient oxygen. African catfish can utilise oxygen like other fish through its gills, thus if dissolved oxygen levels are kept at high levels then one can minimise the work load on some of the catfish to get sufficient oxygen under high stocking densities. When dissolved oxygen levels fall below a certain level it will have a direct effect on the respiration of the fish. It will increase the respiration of the catfish and the catfish will also have to swim to the water surface more often to utilise oxygen from the air. Thus increasing the activity of the catfish and so increasing the energy demand to maintain oxygen levels in the blood and tissues. With the increase in respiration a higher rate of toxic chemicals can be taken up through the gills, increasing the stress on the fish (Lloyd, 1992). As dissolved oxygen decline the body metabolism will become affected by an increase of suffocation and very low levels may cause death. Again the effect on the energy and nutrient balance will be affected as with ammonia and nitrite and the fish will lose growth and as a result the condition of the fish may decrease.

The level of feeding, has the most influence on the operational requirements of the aeration system, and the levels of maintaining dissolved oxygen levels can be decreased by an efficient feed management program. Controlled, conservative levels of continuous feeding will provide uniform levels of dissolved oxygen, while periods of heavy feeding will result in more variable levels of dissolved oxygen (Losordo, 1998). If one keep high feeding levels under conditions of low dissolved oxygen, the wastage of feed will be high and in fact will worsen the situation by decreasing the water quality and by increasing the suspended solids as well as fine dissolved solids, which in turn will increase the oxygen demand of the system, and so increase the strain on growth and condition (Losordo, 1998).

1.2.2.4. Suspended solids

Waste solids are the product of fish wastes, uneaten feed, plankton and clay particles (Swann, 1997). The part of feed not assimilated by the fish is excreted as faeces. Faeces and uneaten feed contribute to waste solids. When broken down by bacteria, faecal solids and uneaten feed will consume dissolved oxygen and generate ammonia-nitrogen. For this reason, waste solids must be removed as quickly and as efficiently as possible. Waste solids can become a big problem in recirculating systems because of the low water exchange rate. Some systems water exchange can be as low as 0 – 5% of the total volume of water per day (Losordo, 1998).

There are three categories of waste solids; settable solids, suspended solids, and fine dissolved solids (Losordo, 1999). Settable solids are those that will settle out of the water within one hour under still conditions and should be removed as quickly as possible (Losordo, 1998). Suspended solids and fine suspended solids are those solids that will not settle and cannot be easily removed. Fine suspended solids (<30 micrometers) contribute more than 50 percent of the total suspended solids in a recirculating system and increase the oxygen demand of a system (Losordo, 1998). Dissolved solids or dissolved organic carbon (protein) contribute to the oxygen demand of the system. Fine and dissolved solids are not easily removed by screening or sedimentation; instead foam fractionation (also referred to as protein skimmers) is used to remove these solids (Timmons, 1994).

All of the above mentioned solids will irritate the gills of the fish and can cause the epithelium cells to swell and this will decrease the oxygen transfer capacity from the water over the gills into the blood, and thus decreasing the system carrying capacity significantly (Losordo, 1998). In situations of high levels of solids in a recirculating system it will have the same effect on the energy balance by increasing the energy needed for respiration and maintaining the balance within the fish.

1.2.3. Water temperature

In certain seasons of the year the fish grows more rapidly, in others it grows more slowly. Each fish specie has its own optimum temperature, at which the rates of metabolism and growth are most rapid. Therefore, deviations in either direction from the optimum temperature will effect the growth rate of the immature fish (Nikoisky, 1963). The temperature not only effects the growth of fish but acts as a signal factor. A reduction of temperature below a certain level leads to a reduction of protein growth and the commencement of the fat accumulation process. This was noted for carp. Changes in the metabolic rate are most closely connected with changes in the temperature of the surrounding water and, the rate of development of fishes is also related to a significant extend to changes in the temperature. (Nikoisky, 1963). Changes in the temperature also causes changes in the toxic actions of various substances upon the fish (Nikoisky, 1963). Warm water fish grow best at temperatures between 25 and 32^{O}C. Roets, 1997, stated that the optimum temperature for the African Sharptooth catfish is at 27^{O}C, and according to Hogendoorn's model for predicting growth in African catfish, the optimum temperature for growth is 28^{O}C (Uys, 1988). Bok *et al* (1984) recorded a drop in mean water temperature during April with the lowest temperature in South Africa of 16.1^{O}C. He found that the mean growth of catfish started to decline at the end of February, and ceased completely and even showed a mass loss in April. Temperature is also important for survival and metabolism of fish. Adeyemo et al, 2003, found a significant ($P<0.05$) difference in haematicrit (Ht), heamoglobin (Hb), and total plasma protein (TPP) values at $23\pm1^{O}C$ and $41\pm1^{O}C$ relative to the control ($29\pm1^{O}C$). A reduced quantity and quality of erytrocytes and a decreased heamoglobin level lead to a deteriorated oxygen supply. Insufficient quantity and quality of red cells would therefore have several effects on metabolism. A decrease in TPP is suggestive of mal-absorbtion (Adeyemo, 2003). A high blood glucose level at low water temperatures is indicative of retarded metabolism and also a indication of sub-lethal stress and Adeyemo, 2003, observed the highest blood glucose level at $23\pm1^{O}C$. Thus, at low temperatures the fish will not eat and use all its energy for the functions for maintenance. The decrease in heamoglobin level with the deteriorated oxygen supply may cause the increase in respiration, again shifting the energy and nutrient balance. Thus, low temperatures may cause a decrease in condition and will cause a decrease in growth.

1.2.4. Stocking densities

Gerking, (1978) stated that some form of regulation occurs in populations at extremes of densities, and that this usually involves some kind of density dependant mortality. This density dependent mortality may operate through intra specific competition for food and space (Gerking, 1978). For the African catfish it can be even competition for space at the water surface to breath air. This researcher also stated that as the population density of fish and, hence, their food consumption increases, the amount of food consumed per unit feeding effort (catch per unit effort) will tend to decrease. In other words as the density increases the amount of feed given will increase and according to Gerking the amount of feed taken by the fish will in fact decrease, leading to a slower growth rate. Hengsawat *et.al.* (1997) found that the mean fish weight for African catfish were highest at lowest densities and mean weights decreased with increasing density, but the total harvest and production were directly related to stocking density. It is clear that an increase in stocking density results in an increase in stress, which leads to an increase energy requirements causing reduced growth and food utilisation. Hossain *et al.* (1998) also found that growth rate for the African catfish was significantly higher at lower stocking densities. However, at low stocking densities cannibalism may increase (Hossain, 1998). A reason for this is that African catfish may be highly territorial. Territoriality promotes resource monopolisation, which is the uneven distribution of resources among individual fish (Grant, 1997). In a aquaculture system this resource is food and will lead to variation in body mass and condition. It is thus in the aquaculturists interest to minimise aggressive and territorial behaviour that wastes energy, causes damage to subordinates, and promotes a variation in growth and condition (Grant, 1997). In African catfish culture this can be achieved by keeping the stocking levels at its optimum and, under such conditions, aggressive individuals do not monopolise a large share of the food. Consequently, identifying the optimum stocking density is a critical factor to achieve maximum growth, maximum condition and minimum level of cannibalism, hence minimum stress levels, to achieve optimum growth and condition.

1.2.5. Stress and disease

Stress is a condition in which an fish is unable to maintain a normal physiological state, because of various factors adversely affecting its well-being (Floyd, 2002). These factors affect the well-being of a fish is called stressors and is any factor that threatens the homeostasis of a fish. Stress is thus caused by placing a fish in a situation which is beyond its normal level of tolerance. Floyd, (2002) divide stressors in four categories: chemical, biological, physical and procedural. Chemical stressors are; poor water qualities, pollution, diet composition and nitrogenous and other metabolic wastes. Biological factors include population density, aggression, territoriality, micro-organisms and macro-organisms. Physical stressors include temperature, light, sounds and dissolved gasses. Procedural stressors include handling, shipping and disease treatments. This researcher also divides the response of fish to stressors in three categories: alarm reaction, resistance and exhaustion. The alarm response is the initial response. In this response the blood sugar levels increase and is caused by a secretion of hormones. This will creates an energy reserve which prepares the fish for emergency action. The osmoregulation is disrupted because of changes in mineral metabolism. A freshwater fish will thus absorb excess water from the environment. This disruption will require extra energy to maintain osmoregulation. Respiration increases, blood pressure increases, and reserve red blood cells are released into circulation. The inflammatory response is suppressed by hormones released. In the resistance period, the fish is able to adapt to stress for a certain period of time. During this period the fish may look and act normal, but is depleting energy reserves because of the extra requirements placed upon the fish. The exhaustion period is recognised by the depletion of the energy reserves, and adaptation fails and the fish is susceptible to disease (Floyd, 2002). Moberg, (1993) illustrates the response of fish and other animals to stress in figure 1.4.

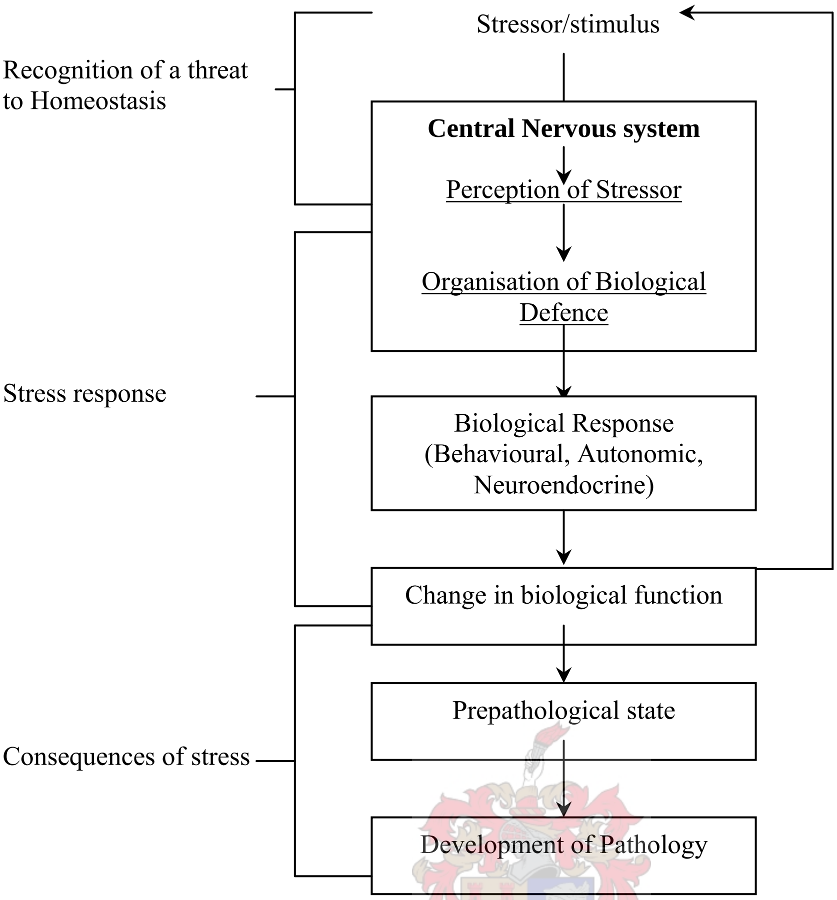

Figure 1.4. Model for the response of animals to stress (Moberg, 1993).

As Floyd (2002), divided the stress response in three categories, so does Moberg's model. This model divides the biological response to stress into three components: recognition, stress response, and the consequences of stress. It is the central nervous system that perceives a threat to homeostasis and organise the fish's biological defence. Three biological defences are available to the fish. Firstly is behaviour. When a fish perceive a threat to its homeostasis and wellbeing it will try and remove itself from the stressor. However, under culture condition this is not always possible. The fish will then have to rely on its autonomic nervous system and neuroendocrine system for a response. Hormones of the neuroendocrine system play an important role. These hormones have a widespread action on the fish and have effects on biological functions as reproduction, growth, metabolism, resistance to disease, and behaviour (Moberg, 1993).

Under stress conditions the fish's resources are diverted from pre-stress activities such as growth to new activities. Moberg (1993) give the glucocorticosteroid hormone cortisol as an example. When the glucocorticosteroid hormone cortisol is secreted during stress it will induce gluconeogenesis, diverting metabolic resources supporting such functions as growth to the production of glucose. It does not matter which responses the fish chooses in response to stress, a change in biological function occurs that will force a cost. Combined stressors could cost the fish sufficient resources to induce a prepathological state and lead to the development of a pathology and disease (Moberg, 1993). It is not possible to predict when the stress on a fish will be acute, but for optimum growth and condition one would like to keep the stress levels as low as possible. All animals including fish can handle a certain amount of stress, but as soon as it becomes acute the fish will stop eating and become susceptible for disease. In turn there will be a loss in condition and growth and an increase in mortalities. The key to prevention of stress is good management. This means maintaining good water quality, good nutrition, and good sanitation. Poor water quality is a common and important stressor of fish and precedes many disease outbreaks (Floyd, 2002). Feed a high quality feed that meets the nutritional requirements of the fish. Proper sanitation implies routine removal of debris from fish tanks and disinfection of containers and equipment between groups of fish. Disinfection of containers and equipment between groups of fish helps minimise transmission of disease from one population to another (Floyd, 2002).

One can clearly see that stress has a major influence on the fish's energy resources and this will affect the growth and condition and thus production. Fish farm management should thus be designed to minimise tress on fish in order to decrease the occurrence of disease outbreaks, and so increasing production. When a disease outbreak occur, the correction of the stressor should precede of accompany disease treatment (Floyd, 2002). A disease treatment is an artificial way of slowing down the invading pathogen so that the fish has time to defend itself with an immune response. This is why it is important to correct the stressors as soon as possible so the fish can use its energy to fight the invading pathogens naturally (Floyd, 2002).

1.2.6. Feed selection

The type of feed used can also influence the condition of catfish. Floating feeds should be used because floating extruded feed allow the aquaculturist to monitor fish feeding activity, thus enabling the manager to stop feeding when the fish are not eating well. This will in turn minimise the effect of feed wastage on the water quality which have a influence on the growth, condition and health of fish. Extruded feeds are more stable than compressed pelleted feeds, thus less nutrients will leach into the water. Feed the largest pellet size that is accepted by the fish. Larger pellets also have a smaller surface-to-volume ratio than smaller pellets, which reduce the rate and the amount of nutrients that leach into the water. High quality feeds will contain less than 1% fines. Extruded feeds will contain the least dust and fines (Ramseyer, 2004).

Feedbags should be checked for date of manufacturing. Avoid feed that is older than 3 months. Masser, 1999, suggests to stop using feed that is older than 60 days from the manufacture date. Fish will not fully utilise the feed if it is deficient in nutrients due to break down over time, which will affect the growth and condition of the fish. Molds on feed may produce Alfa toxins, which can stress or kill fish. A disease known, as “no blood” is associated with feed that is deficient in certain vitamins and “broken back disease” from vitamin C deficiencies. This will cause a serious imbalance in the fish and it will lead to poor growth and condition of the fish. If these diseases occur the only thing the manager can do is to discard the feed and to purchase new feed (Masser,1999; Riche, 2003 Ramseyer, 2004;)

1.3. Determining the condition of fish

The general wellbeing of fish is often described in terms of its general condition, such as poor, good, or excellent. By classifying or describing a catfish just by length or weight may give a farm manager limited information. The fish may be very long but very thin and thus very little fillet mass, and this is the exact opposite a farm manager would want. The farm manager thus needs to understand weight-length relationships and its influence on the condition of the fish. By using a condition index a farm manager may get a better idea of the total well being of the fish.

1.3.1. Fulton’s Condition Index *K*:

The condition of fish is usually based on a visual assessment of the fish, and only an experienced person will be able to tell if a fish is in a good or poor condition (Barnham, 1998). It will thus be more practical to allocate a numerical value to the state of condition of a fish. In order to calculate a numerical value, one can calculate the condition of a fish as the condition factor or coefficient of condition. This factor is expressed as Fulton’s condition index, or the *K-factor*; equation 1.3 (Barnham, 1998; Williams, 2000). This factor is directly influenced by the length-weight relationship.

$$K = \frac{100\,000W}{L^3} \qquad (1.3)$$

Where: W = the weight of the fish in grams

L = the length of the fish in millimetres

The value of the b exponent is explained by the slope of the equation's logarithmic form:

$$\text{Log } W = \log a + b \log L$$

The value of the b exponent provides important information on fish growth and in turn whether Fulton's condition index *K* can be used or not. When b = 3, the increase in weight is isometric. This means relative growth of both variables is identical (Santos, 2002). In other words, as the fish length increases the weight increases accordingly. There are many instances when the assumption of isometric growth will not be met, i.e. the b exponent is not equal to 3. When the value of b is not equal to 3, weight increase is allometric. If b>3 (positive allometry) then there is a significant positive relationship between *K* and fish length which indicates that *K* will increase with increasing length, thus as the fish length increases the more rotund the fish will become. When b < 3 (negative allometry) then *K* will decrease with increase in length, thus as the fish length increases the less rotund the fish will become (Jones, 1999). Since Fulton's condition index *K* assumes isometric growth (b = 3) then a different approach must be taken when b is not equal to 3. Jones *et al*., (1999) compared a proposed model ($M = BL^2H$), where the height of the fish is also incorporated to give a more accurate condition factor when b is not equal to 3.

The condition of a fish is influenced by the age of a fish, sex, season, stage of maturation, fullness of the gut, type of food consumed, amount of fat reserved and the degree of muscular development (Barnham 1998; Williams, 2000). Weight-length relationships provide practical information on fish biology, ecology, health and physiology. Length-weight relationships are used to predict growth in terms of weight as a function of length (Jones, 1999). Other uses include; the estimation of weight at age and the conversion of growth-in-length equations to growth-in weight, the calculation of production and biomass of a fish population. Weight-length relationships also allow life history and morphological comparison between fish populations from different ponds (Santos, 2002). With this morphological comparison one can compare the condition of wild fish populations to the condition of fish populations in an intensive recirculating system.

Female African Sharptooth Catfish eggs can weigh 15% to 20% of the total body weight of the fish (De Graaf, 1996) Thus, the *K-factor* will decrease significantly during spawning. H.J. Ratz stated that cod with a low condition index presumably having experienced adverse physical environmental conditions or insufficient nutrition. They used Fulton's *K-factor* as a simple and adequate way to estimate the energy levels of cod. They found that the condition of cod follow inter-annual variations and seasonal cycles, with lower energy reserves occurring during spawning (Ratz 2003). The females shedding their eggs can explain this. The condition factor does not only reflect the feeding condition of the fish but the gonad development as well (Lizama, 2002). So when a female catfish get sexually matured the *K-factor* will increase. During winter period's fish use their energy reserves (fat stores and muscle proteins), therefore they eat less and the *K-factor* will decrease according. When weighing and measuring a fish just after it had eaten the *K-factor* will be higher due to the fullness of the gut. The type of feed fed and the feed management taken influences amount of fat reserve and muscle protein.

Ideally condition of fish should be taken account of the sex of the fish, however, this is not always possible or practical. Feeding record needs to be taken as accurately as possible. This can explain a lot if the *K-factor* is high or low. Factors like water qualities, stress, disease, and stocking densities all play a role in the condition of a fish. All of these factors need to be taken into account when the condition of a fish is interpreted.

To get results of length-weight relationship or condition factor one needs to implement a proper population inventory. The main purpose of this is to document length increases and weight gains. Data acquired from the inventory provides the status of the population in regards with the carrying capacities of the system and the size variation in a certain population of fish. Size variation in *Clarias gariepinus* is of great importance due to of the increase of cannibalism that occurs when there is a large size variation in the population. Highest levels of cannibalism occur during the fry and fingerling stages, therefore the farmer must take great care to ensure as little size variation as possible at this stage of production. Klontz, (2004) suggested the inventory process should begin when a system is stocked and suggested that this process should occur as follows. Firstly, determine the average weight of the fish, the biomass and the number of fish. Take a minimum of 16 fish (preferably more, about 40, if there is time to do more) and measure the individual length and weight. Now you can calculate the mean, midrange and standard deviation as well as the condition factor. At the end of a cycle determine the average weight of the fish, the biomass and the number of fish. Take a minimum of 16 fish (preferably more, about 40, if there is time to do more) and measure individual length and weight. Now you can calculate the mean, midrange and standard deviation again as well as the condition factor. This will detect size bias from the original population to the new population (Klontz, 2004).

1.4. Conclusion

By applying proper population inventories one can determine the weight-length relationship of fish populations. One can also get valuable information from the growth exponent b on the growth of the fish which can be either isometric or allometric. Fulton's condition index *K* can only be used if the fish has an isometric growth. Condition factors may be used as indicators of the well being or fitness of the fish and may be used as a method for quantification of production parameters such as health and growth. Factors such as water qualities, temperature, stress and disease, stocking densities, sex and age of the fish, can all play a role in the condition of catfish. It is thus important for the aquaculturist to keep these factors in mind when calculating the condition of catfish, for he/she might be able to find answers to certain variations in the condition and growth of the farmed catfish. Thus in order for an aquaculturist to make accurate decisions there must be proper standard operating procedures (SOP) and good manufacturing practices (GMP) in place. This will allow the aquaculturist to keep track of variables in the production period in terms of feeding, disease control, water qualities, water temperature, log of unusual occurrences like power failure etc. When the aquaculturist has ensured that good SOP's and GMP's are in place the use of the condition factor to quantify production parameters will allow the aquaculturist to solve unanswered questions with regard to why the fish did not performed and what the possible causes thereof may be, in order to prevent that from happening again in the future and to improve general production efficiency.

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Chapter 2

APPLLICATION OF FULTON'S *K-FACTOR* IN THE INTENSIVE CULTURE OF AFRICAN SHARPTOOTH CATFISH *CLARIAS GARIEPINUS*

2.1. Abstract

Fulton's condition factor *K* is derived from the weight-length relationship of fish and provides useful information on the nutritional and health status of fish. With the recent renewed interest in the commercial culture of African sharptooth catfish in South Africa, suitable methods for the quantification of some production performance parameters such as growth and health measurements need to be established for application in intensive catfish culture. Especially in the light of the large size variation in offspring spawned from undomesticated fish that may eventually increase cannibalism. The aim of the trial was to establish and compare length-weight relationship and condition factors for future use in commercial culture conditions.

Catfish fry with average weight of 1.912g ± 0.789 and average length of 59.375mm ± 8.812 were equally allocated into ten 1000L-recirculating tanks. The fish were fed a commercial feed to apparent satiation at a frequency of 5 times per day. Sixteen fish were sampled out of each treatment. Weight (g) and length (mm) of each fish were recorded every seven days over a trial period of 175 days from which Fulton's condition index *K* was calculated. Results were analysed for significant differences using one-way ANOVA and Tukey's pair wise comparison test for the various parameters.

Growth parameters (a = -5.083, b = 3.004, R^2 = 99.4%) derived from the logarithmic relationship between body weight and length indicated an isometric growth over the duration of the trail. No significant differences (P>0.005) in condition factors were found between treatments at initial stocking but significant differences were found at the end of the trail period for both weight and condition factor. No significant difference (P> 0.005) in length measurements was found between treatments at the end of the trial. These results indicate that Fulton's *K* may be a more sensitive method for body scoring than length measurements in African Sharptooth Catfish.

2.2. Introduction

African Sharptooth Catfish *Clarias gariepinus* is widely distributed throughout Southern Africa as well as through central West Africa (Bruton, 1988). In recent years there has been a renewed interest in the commercial culture of African Sharptooth Catfish in Southern Africa. Its robust characteristics and its air breathing capabilities makes the African catfish a good candidate for culture in intensive recirculating systems.

Weight-length relationships provide practical information on fish biology, ecology, health and physiology. Length-weight relationships are used to predict growth in terms of weight as a function of length (Jones, 1999). Other uses include the estimation of weight at age and the conversion of growth-in-length equations to growth-in weight, the calculation of production and biomass of a fish population. Weight-length relationships also allow life history and morphological comparison between fish populations from different ponds (Santos, 2002). With this morphological comparison one can compare the condition of wild fish populations to the condition of fish populations in an intensive recirculating system, since brood fish mainly comes from the wild there is no domesticated gene pool. There is known that size variation in African catfish is of great importance because of the increase of cannibalism that occurs when there is large size variation. Highest levels of cannibalism occur during the fry and fingerling stage.

Fish frequently gets described to be either in a poor, good or excellent condition. This measure is usually based on a visual assessment of the fish (Barnham, 1998). In fish the condition factor reflects information on the physiological state of the fish in relation to its welfare (Lizama, 2002). This factor is expressed as Fulton's condition index, or the *K-factor* (Barnham, 1998):

$$K = \frac{100\,000W}{L^3}$$

with W the body weight of the fish and L the length of the fish and the value of the exponent b explained by the slope of the equation's logarithmic form:

$$\text{Log } W = \log a + b \log L$$

The value of the b exponent provides important information on fish growth and in turn whether Fulton's condition index K can be used or not. When b is equal to 3, the increase in weight is isometric. This means relative growth of both variables is identical (Santos, 2002). There are many instances when the assumption of isometric growth will not be met, i.e. the b exponent is not equal to 3. If b is larger than 3 then there is a significant positive relationship between *K* and fish length which indicates that K will increase with increasing length, and when b is less than 3 then *K* will decrease with increase in length (Jones 1999). Since Fulton's condition index *K* assumes isometric growth (b = 3), a different approach must be taken when b is not equal to 3. Jones *et al*. (1999) compared a proposed model ($M = BL^2H$), where the height of the fish is also incorporated to give a more accurate condition factor when b is not equal to 3.

Due to health and nutritional status, the weight of fish, of the same age, may differ greatly while the length may show a minimum variance. Goncalves, *et al*., (1997) stated that the weight parameter may vary seasonally, daily, and between habitats, unlike parameter b that generally does not vary significantly.

Ratz, (2003) stated that cod with a low condition index presumably having experienced adverse physical environmental or insufficient nutrition. They used Fulton's *K-factor* as a simple and adequate way to estimate the energy levels of cod. They found that the condition of cod follow inter-annual variations and seasonal cycles, with lower energy reserves occurring during spawning (Ratz, 2003).

The aim of this trail was to provide information on weight-length relationships and its practical applications on first generation fish populations in an intensive recirculating system, and to calculate a practical *K-factor* calculation chart for the African Sharptooth catfish.

2.3. Materials and methods

African Sharptooth catfish fry with average weight of 1.9g ± 0.7867 and average length of 59.375mm ±8.812 were used in this trail. Fry were evenly divided into ten 1000L-recirculating tanks. After the first month the fish were moved to holding cages of 1m x 1.15m x 0.4m in the recirculating system. Fish were fed a commercial feed (Aquanutro Catfish pre-starter) ad lib at a frequency of 5 times per day. Sixteen fish were sampled out of each treatment. Individual weight (g) and length (mm) of sampled fish were recorded every seven days over a trial period of 175 days; feed intake was recorded for each period. Length was measured from the centre between the two maxillary barbels on the mouth to the base of the caudal fin. Fulton's condition index *K* was used to express the condition of the fish. Results were analysed for significant differences using one-way ANOVA and Tukey's pair wise comparison test for the various parameters.

The mean condition factor was used as the average condition African catfish are likely to achieve, and the standard deviation on the mean condition factor was used to determine the upper and lower limits African catfish is likely to achieve. By using this information a *K-factor* calculation chart or analytical model, was formulated.

2.4. Results and discussion

Growth parameters (a = -5.083, b = 3.004, R^2 = 99.4%) from the logarithmic relationship between body weight (*W)* and standard length (*L)* indicated an isometric growth through the duration of the trail (Figure 2.1). Results from logarithmic weight-length relationship (b = 3) supported the use of Fulton's *K* to express individual fish condition. These data are supported by previous researchers of the African catfish and was posted on fishbase indicating a calculated mean b value of 2.958 ± 0.223 (Eli & Kit, 2004).

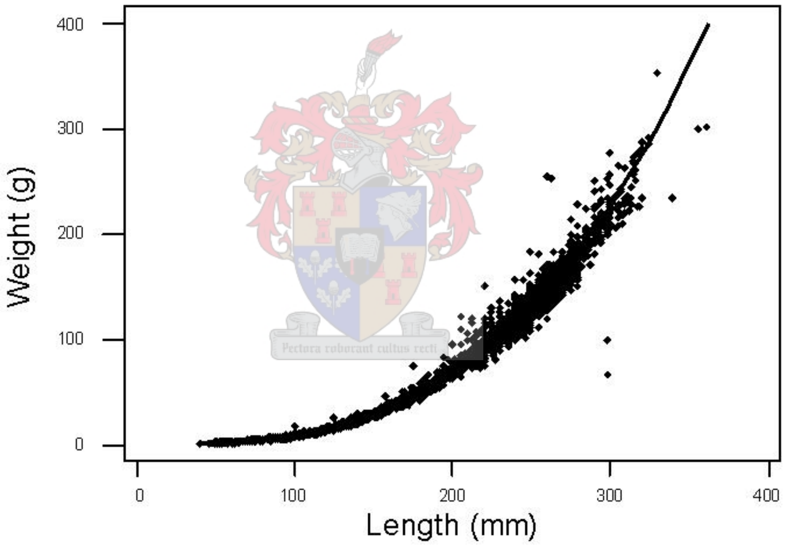

Figure 2.1 Logarithmic relationship between body weight and length of the fish (a = -5.083, b = 3.004, R^2 = 99.4%, n = 160)

The isometric growth (b = 3) means that Fulton's condition index (*K*) is an appropriate equation for the description of fish condition in this trail. *K* results are presented in table 1. With one-way ANOVA and Tukey's pair wise comparison, no significant differences (P>0.05) in weight between ponds, length between ponds and condition factors between ponds were found at the beginning of the trail, where weight (g) = 1.8813 ± 0.7719, length (mm) = 59.375 ± 8.812 and condition factor = 0.8391 ± 0.1631. Significant differences (P<0.05) were found at the end of the trail for weight between ponds and condition factor between ponds. No significant difference (P> 0.05) between length and ponds were found at the end of the trial. The mean condition factor for African catfish in this study was 0.856 ± 0.187.

Table 2.1 Descriptive statistics on mean length, weight and CF between ponds (n = 160).

Pond	Mean length (± stdev)	Mean weight (± stdev)	Condition factor (± stdev)
1	268.31 ± 22.33	157.88 ± 39.01^{a}	0.8044 ± 0.0477^{ab}
2	264.56 ± 29.22	166.50 ± 60.26^{a}	0.8763 ± 0.1661^{a}
3	262.31 ± 16.74	144.06 ± 30.07^{a}	0.7881 ± 0.0541^{ab}
4	275.00 ± 25.03	170.94 ± 53.23^{a}	0.7988 ± 0.0593^{ab}
5	268.44 ± 25.74	155.75 ± 48.35^{a}	0.7825 ± 0.0412^{ab}
6	255.00 ± 21.67	139.19 ± 35.26^{ab}	0.8256 ± 0.0540^{ab}
7	252.13 ± 17.61	135.69 ± 28.14^{ab}	0.8381 ± 0.0586^{a}
8	265.94 ± 31.44	165.38 ± 45.06^{b}	0.8744 ± 0.1551^{a}
9	249.88 ± 13.44	124.38 ± 19.11^{ab}	0.7938 ± 0.0372^{ab}
10	270.00 ± 30.40	194.31 ± 66.52^{a}	1.0094 ± 0.4085^{b}

Mean CF with different superscript letters in each column differs significantly (P<0.05)

The condition of a fish is influenced by it's age, sex, season, stage of maturation, fullness of the gut, type of food consumed, degree of muscular development, amount of fat reserved, and may also be influenced by water qualities, water temperature, stress and disease, and stocking densities (Barnham, 1998; Williams, 2000). Female African Sharptooth Catfish eggs can weigh 10% to 15% of the total body weight of the fish. As female catfish get sexually matured the *K-factor* will increase, and during spawning of the eggs, the *K-factor* will decrease significantly. Thus the condition factor does not only reflect on the feeding condition of the fish but the gonad development as well (Lizama, 2002).

Mean water temperature for this trial was 25.32^{0}C ± 1.55. According to Hogendoorn's model for predicting the growth rate, the optimum temperature for growth in Clarias gariepinus is 28^{0}C (Uys, 1988). At optimum temperatures fish grow faster and convert feed more efficiently due to a higher metabolism (Masser, 1999). A decreasing trend in the condition factor was observed towards the end of the trial that may possibly be explained by a decrease in water temperature towards the end of the trial, however, the temperature has a poor correlation, which has no significant (P>0.05) meaning.

In this trial samples of fish were taken at a weekly interval, but all the fish were handled in weeks 1, 5, 7, 10, 20 and 25. When one refer to graph 2.2, one can see a drop in mean condition for the following week. The extreme drop in week 4 and the two peaks in weeks 20 and 25 can be faulty data, when the sample were taken, more weaker fish on week 4 might have been caught and visa versa for weeks 20 and 25. Thus, the frequent handling of fish may have played a role in the variation of the condition, and it is suggested weighing should be done with longer intervals.

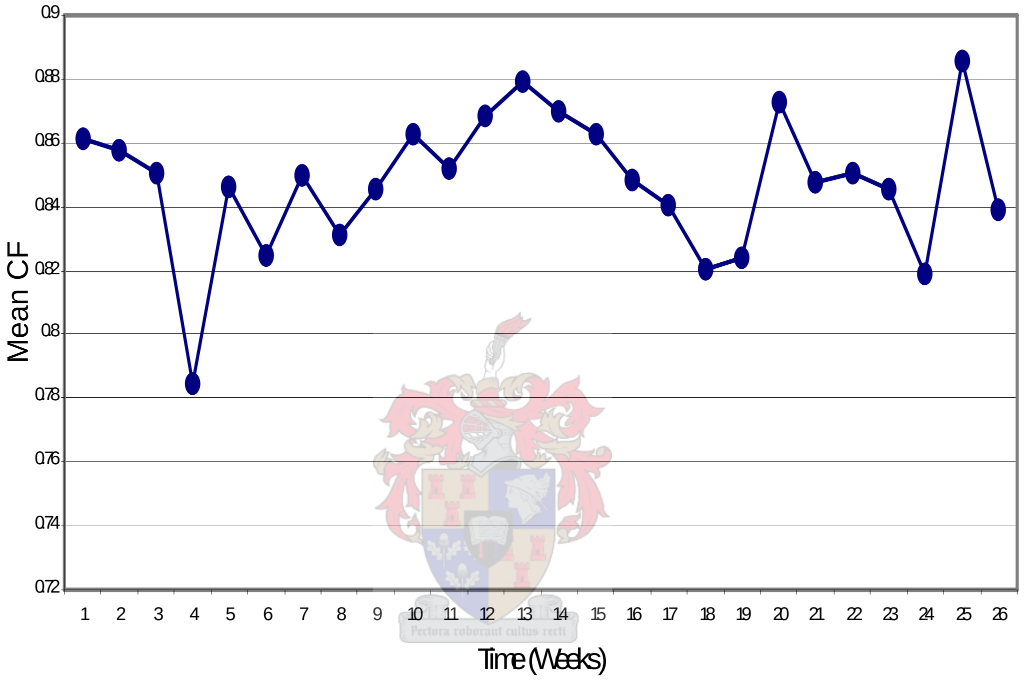

Figure 2.2. Mean Condition Factor over 26 weeks

Fulton's condition index K is highly dependant upon the exterior of the fish. This means that in high bodied fishes with a broad back, the ratio of the weight to length is greater than in elongated fishes (Nikoisky, 1963). One can thus not apply a *K-factor* calculation chart of other fish species, for example Barnham's chart for Salmonid fishes, to African Sharptooth catfish (Barnham, 1998). Condition indices for African catfish must thus be determined to draft a *K-factor* calculation chart for African catfish.

According to this study, one can conclude that a condition factor of 0.856 an average condition is for African catfish. By adding and subtracting the standard deviation (± 0.187) from the mean, one can calculate the most likely upper (1.04) and lower (0.669) *K-factor* limits for African catfish. From these data a *K-factor* calculation chart for African catfish can be calculated using Fulton’s equation based on a similar *K-factor* calculation chart for Salmonid fish (Barnham, 1998). To improve the usability of the *K-factor* chart the condition indices are overlapping these upper and lower limits slightly. Weight intervals of 5g were used and length intervals of 5mm were used compared to Barnham’s chart for Salmonid fish where weight intervals of 25g and length intervals of 25mm were used (Barnham, 1998). Figure 2.3 and 2.4 are *K- factor* calculation charts derived from the results of this study for African Sharptooth catfish. The purpose of these charts is to assist a catfish farmer to calculate the condition of the fish and to make it possible to determine if the catfish is in a good condition or not.

From the results of the mean condition factor, one can see that the aquaculturist must strive to reach a condition factor of 1.04 for African catfish, and if the condition factor is below the average (0.856) the farmer knows that some factor in the production cycle is influencing the condition of the fish and he/she can then investigate the rectify the problem.

Weight (g)	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290
150																																	1.16	1.09	1.02	0.96	0.90	**0.85**	0.81	0.76	0.72	0.68	0.65	0.62
145																																1.19	1.12	1.05	0.99	0.93	**0.87**	0.82	0.78	0.74	0.70	0.66	0.63	
140																																1.15	1.08	1.01	0.95	0.90	**0.84**	0.80	0.75	0.71	0.67	0.64	0.60	
135																															1.19	1.11	1.04	0.98	0.92	**0.86**	0.81	0.77	0.73	0.69	0.65	0.61		
130																															1.14	1.07	1.00	0.94	**0.88**	**0.83**	0.78	0.74	0.70	0.66	0.63			
125																														1.17	1.10	1.03	0.96	0.90	**0.85**	0.80	0.75	0.71	0.67	0.64	0.60			
120																														1.13	1.05	0.99	0.92	**0.87**	0.82	0.77	0.72	0.68	0.64	0.61				
115																													1.16	1.08	1.01	0.95	**0.89**	**0.83**	0.78	0.74	0.69	0.65	0.62					
110																												1.19	1.11	1.03	0.97	0.90	**0.85**	0.80	0.75	0.70	0.66	0.63						
105																												1.13	1.06	0.99	0.92	**0.86**	0.81	0.76	0.71	0.67	0.63	0.60						
100																											1.16	1.08	1.01	0.94	**0.88**	**0.82**	0.77	0.72	0.68	0.64	0.60							
95																										1.19	1.10	1.03	0.96	0.89	**0.83**	0.78	0.73	0.69	0.65	0.61								
90																										1.13	1.04	0.97	0.91	**0.85**	0.79	0.74	0.69	0.65	0.61									
85																									1.15	1.06	0.99	0.92	**0.86**	0.80	0.75	0.70	0.65	0.61										
80																								1.17	1.08	1.00	0.93	**0.86**	0.80	0.75	0.70	0.66	0.62											
75																							1.18	1.09	1.01	0.94	**0.87**	0.81	0.75	0.70	0.66	0.62												
70																							1.11	1.02	0.94	**0.88**	0.81	0.76	0.70	0.66	0.61													
65																						1.11	1.03	0.95	**0.88**	0.81	0.75	0.70	0.65	0.61														
60																					1.12	1.03	0.95	**0.87**	0.81	0.75	0.70	0.65	0.60															
55																				1.12	1.03	0.94	**0.87**	0.80	0.74	0.69	0.64																	
50																			1.11	1.02	0.93	**0.86**	0.79	0.73	0.67	0.63																		
45																		1.10	1.00	0.92	**0.84**	0.77	0.71	0.66	0.61																			
40																1.19	1.07	0.98	**0.89**	**0.81**	0.75	0.69	0.63																					
35															1.15	1.04	0.94	**0.85**	0.78	0.71	0.65	0.60																						
30														1.09	0.98	**0.89**	**0.81**	0.73	0.67	0.61																								
25												1.14	1.02	0.91	**0.82**	0.74	0.67	0.61																										
20										1.16	1.02	0.91	**0.81**	0.73	0.66																													
15								1.13	0.99	**0.87**	0.77	0.68	0.61																															
10					1.17	1.00	**0.86**	0.75	0.66																																			
5	1.19	0.98	**0.81**	0.69																																								

Length (mm)

Figure 2.4 *K-factor* calculation chart (Barnham, 1998)

Weight (g)	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305	310	315	320	325	330	335	340	345	350	355	360	365
300													1.17	1.11	1.06	1.01	0.96	0.92	**0.87**	**0.83**	0.80	0.76	0.73	0.70	0.67	0.64	0.62
295													1.15	1.09	1.04	0.99	0.94	0.90	**0.86**	0.82	0.78	0.75	0.72	0.69	0.66	0.63	0.61
290												1.19	1.13	1.07	1.02	0.97	0.93	0.89	**0.84**	0.81	0.77	0.74	0.71	0.68	0.65	0.62	0.60
285												1.17	1.11	1.06	1.00	0.96	0.91	**0.87**	**0.83**	0.79	0.76	0.73	0.69	0.66	0.64	0.61	
280												1.15	1.09	1.04	0.99	0.94	0.90	**0.85**	0.82	0.78	0.74	0.71	0.68	0.65	0.63	0.60	
275											1.19	1.13	1.07	1.02	0.97	0.92	0.88	**0.84**	0.80	0.77	0.73	0.70	0.67	0.64	0.61		
270											1.17	1.11	1.05	1.00	0.95	0.91	**0.86**	0.82	0.79	0.75	0.72	0.69	0.66	0.63	0.60		
265											1.14	1.09	1.03	0.98	0.93	0.89	**0.85**	0.81	0.77	0.74	0.70	0.67	0.65	0.62			
260										1.18	1.12	1.07	1.01	0.96	0.92	**0.87**	**0.83**	0.79	0.76	0.72	0.69	0.66	0.63	0.61			
255										1.16	1.10	1.05	0.99	0.94	0.90	**0.86**	0.82	0.78	0.74	0.71	0.68	0.65	0.62				
250										1.14	1.08	1.03	0.97	0.93	0.88	**0.84**	0.80	0.76	0.73	0.70	0.66	0.64	0.61				
245									1.18	1.12	1.06	1.00	0.95	0.91	**0.86**	0.82	0.78	0.75	0.71	0.68	0.65	0.62	0.60				
240									1.15	1.09	1.04	0.98	0.93	0.89	**0.85**	0.81	0.77	0.73	0.70	0.67	0.64	0.61					
235								1.19	1.13	1.07	1.02	0.96	0.92	**0.87**	**0.83**	0.79	0.75	0.72	0.68	0.65	0.63	0.60					
230								1.17	1.11	1.05	0.99	0.94	0.90	**0.85**	0.81	0.77	0.74	0.70	0.67	0.64	0.61						
225								1.14	1.08	1.02	0.97	0.92	**0.88**	**0.83**	0.79	0.76	0.72	0.69	0.66	0.63	0.60						
220							1.18	1.12	1.06	1.00	0.95	0.90	**0.86**	0.81	0.78	0.74	0.70	0.67	0.64	0.61							
215							1.16	1.09	1.03	0.98	0.93	0.88	**0.84**	0.80	0.76	0.72	0.69	0.66	0.63	0.60							
210						1.19	1.13	1.07	1.01	0.96	0.91	**0.86**	0.82	0.78	0.74	0.70	0.67	0.64	0.61								
205						1.17	1.10	1.04	0.99	0.93	0.89	**0.84**	0.80	0.76	0.72	0.69	0.66	0.63	0.60								
200						1.14	1.07	1.02	0.96	0.91	**0.86**	0.82	0.78	0.74	0.70	0.67	0.64	0.61									
195					1.18	1.11	1.05	0.99	0.94	0.89	**0.84**	0.80	0.76	0.72	0.69	0.65	0.62	0.60									
190					1.15	1.08	1.02	0.97	0.91	**0.87**	0.82	0.78	0.74	0.70	0.67	0.64	0.61										
185				1.18	1.12	1.05	0.99	0.94	0.89	**0.84**	0.80	0.76	0.72	0.69	0.65	0.62											
180				1.15	1.09	1.02	0.97	0.91	**0.87**	0.82	0.78	0.74	0.70	0.67	0.63	0.60											
175			1.19	1.12	1.06	1.00	0.94	0.89	**0.84**	0.80	0.76	0.72	0.68	0.65	0.62												
170			1.16	1.09	1.03	0.97	0.91	**0.86**	0.82	0.77	0.73	0.70	0.66	0.63	0.60												
165		1.19	1.12	1.06	1.00	0.94	0.89	**0.84**	0.79	0.75	0.71	0.68	0.64	0.61													
160		1.16	1.09	1.02	0.96	0.91	**0.86**	0.81	0.77	0.73	0.69	0.66	0.62														
155	1.19	1.12	1.05	0.99	0.93	**0.88**	**0.83**	0.79	0.75	0.71	0.67	0.64	0.60														

Length (mm)

Figure 2.4. ***K -factor*** **calculation chart (Barnham, 1998)**

2.5. Conclusion

From these results it can be concluded that the condition factor is a helpful measurement tool to assess differences between fishes in comparison to weight and length. Condition factor can also be a helpful managerial parameter to reflect on a production period in as far as to identify possible problems in relation to the efficiency of growth and general wellbeing. Thus if the catfish has an isometric growth, the aquaculturist can then use Fulton’s condition index *K* to calculate the condition of the African catfish by using the *K-factor* calculation charts for African sharptooth catfish. According to this study, the aquaculturist must strive for an above average condition factor of 1.04 for the African Sharptooth catfish.

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APPENDIX A: Mean Values

Treatment	1			2			3			4			5		
Day	**L(mm)**	**W(g)**	**CF**	**L(mm)**	**W(g)**	**CF**	**L(mm)**	**W(g)**	**CF**	**L(mm)**	**W(g)**	**CF**	**L(mm)**	**W(g)**	**CF**
0	60	1.94	0.90	60	2.06	0.93	61	2.00	0.87	59	1.75	0.87	60	1.88	0.87
7	67	2.75	0.90	69	3.19	0.97	70	3.38	0.99	68	3.31	1.03	79	4.38	0.87
14	82	5.69	1.03	79	4.50	0.91	78	4.94	1.06	79	4.50	0.93	86	6.25	0.99
21	95	8.25	0.95	98	8.00	0.85	106	10.75	0.91	95	7.50	0.87	100	10.13	1.02
28	116	13.56	0.87	123	16.94	0.90	126	17.56	0.88	124	16.31	0.86	127	17.44	0.85
35	130	17.94	0.82	139	25.25	0.93	133	21.50	0.92	138	22.94	0.87	130	19.69	0.90
42	139	23.81	0.89	141	25.88	0.92	154	31.50	0.87	145	27.63	0.91	145	26.56	0.88
49	145	26.44	0.87	158	34.75	0.89	155	33.19	0.89	154	31.50	0.86	145	29.94	0.98
56	153	32.63	0.92	166	38.81	0.84	157	35.56	0.91	168	41.13	0.86	154	32.94	0.90
63	162	38.75	0.91	172	40.56	0.80	165	39.56	0.88	175	46.13	0.87	159	36.25	0.90
70	173	48.69	0.94	179	50.25	0.87	167	42.38	0.91	177	49.25	0.89	169	42.81	0.89
77	185	54.69	0.87	182	55.63	0.92	182	55.81	0.92	186	62.25	0.97	177	49.75	0.89
84	192	64.88	0.91	202	73.75	0.90	193	67.69	0.94	191	62.25	0.90	194	63.81	0.88
91	208	80.13	0.89	207	77.00	0.87	220	90.31	0.85	216	82.94	0.82	198	70.56	0.91
98	218	88.88	0.85	226	96.75	0.84	232	103.88	0.83	222	92.63	0.85	201	71.31	0.88
105	224	96.69	0.87	228	99.50	0.84	235	111.88	0.86	233	104.25	0.83	231	103.19	0.84
112	232	103.13	0.83	234	105.13	0.82	238	114.38	0.85	239	110.75	0.81	232	105.00	0.84
119	237	111.06	0.83	246	118.19	0.80	239	117.31	0.85	244	123.31	0.84	233	107.50	0.85
126	241	121.06	0.86	247	126.13	0.84	241	119.81	0.86	246	129.75	0.87	243	114.00	0.80
133	245	129.38	0.88	250	139.25	0.89	241	122.31	0.87	248	132.88	0.88	249	125.81	0.82
140	248	131.31	0.86	252	139.94	0.87	250	138.75	0.89	249	134.63	0.87	251	139.13	0.88
147	249	132.75	0.86	256	148.13	0.89	253	139.75	0.86	250	135.50	0.87	253	140.69	0.87
154	249	134.94	0.88	257	149.19	0.88	253	141.56	0.87	251	139.00	0.88	254	140.88	0.86
161	261	148.56	0.83	258	150.25	0.87	254	144.06	0.88	256	140.56	0.84	255	141.25	0.85
168	261	149.94	0.84	259	150.94	0.87	255	145.63	0.88	259	148.94	0.86	258	149.44	0.87
175	268	157.88	0.82	265	166.50	0.90	261	157.69	0.89	275	170.94	0.82	268	155.75	0.81

Continued

Treatment	6			7			8			9			10		
Day	**L(mm)**	**W(g)**	**CF**	**L(mm)**	**W(g)**	**CF**	**L(mm)**	**W(g)**	**CF**	**L(mm)**	**W(g)**	**CF**	**L(mm)**	**W(g)**	**CF**
0	59	1.88	0.93	59	1.81	0.89	59	1.81	0.87	57	1.81	0.99	61	2.06	0.90
7	85	5.81	0.95	78	4.06	0.87	85	5.81	0.95	81	4.75	0.89	75	4.19	0.99
14	86	5.88	0.94	81	5.44	1.03	89	6.81	0.98	90	7.31	1.01	95	8.13	0.95
21	92	7.81	1.00	100	9.69	0.97	102	10.50	0.99	104	10.06	0.90	95	8.63	1.00
28	122	15.63	0.86	120	15.63	0.91	127	17.44	0.85	127	18.31	0.89	127	18.31	0.89
35	131	19.25	0.85	136	22.75	0.91	129	19.19	0.89	131	20.56	0.91	138	23.19	0.89
42	149	30.56	0.92	142	24.88	0.87	152	30.44	0.87	142	24.63	0.87	143	25.56	0.87
49	152	32.06	0.92	149	28.63	0.87	156	34.63	0.91	153	31.50	0.88	152	31.56	0.90
56	154	33.19	0.91	158	33.88	0.87	161	34.13	0.82	162	37.31	0.87	160	35.06	0.86
63	159	37.31	0.92	165	40.25	0.90	171	43.69	0.88	162	38.50	0.90	175	46.00	0.86
70	166	39.44	0.86	179	50.19	0.87	180	49.25	0.85	167	40.44	0.87	183	52.94	0.87
77	177	51.75	0.93	183	53.19	0.87	189	58.06	0.87	181	50.13	0.84	183	52.69	0.86
84	196	67.31	0.89	192	63.31	0.90	194	66.63	0.91	193	63.56	0.89	200	68.94	0.87
91	196	66.75	0.88	198	67.81	0.88	196	66.75	0.88	196	65.38	0.87	201	72.63	0.90
98	203	74.00	0.89	204	74.88	0.88	201	72.25	0.89	203	73.19	0.88	206	76.88	0.88
105	212	83.25	0.87	216	89.06	0.88	207	76.13	0.86	207	77.56	0.88	207	78.25	0.88
112	228	98.06	0.83	219	88.38	0.85	215	86.25	0.87	211	81.31	0.87	215	86.19	0.87
119	234	105.19	0.82	230	109.63	0.90	223	94.75	0.85	215	86.44	0.88	219	91.19	0.86
126	237	112.25	0.84	235	113.19	0.87	229	103.88	0.86	218	91.81	0.89	221	91.44	0.85
133	242	114.44	0.81	237	117.69	0.89	239	131.50	0.96	220	95.31	0.89	232	112.06	0.90
140	244	128.44	0.88	237	118.94	0.89	252	141.31	0.89	229	103.06	0.86	252	143.56	0.90
147	248	134.25	0.88	238	119.38	0.88	254	143.63	0.87	231	107.19	0.87	255	145.31	0.88
154	251	139.19	0.88	242	125.31	0.88	256	145.69	0.87	232	108.00	0.87	256	147.31	0.88
161	252	144.00	0.90	248	133.06	0.87	259	150.31	0.87	233	116.19	0.92	262	161.81	0.90
168	255	147.31	0.89	250	133.50	0.85	260	153.25	0.87	246	121.69	0.82	277	187.00	0.88
175	262	153.00	0.85	252	135.69	0.85	266	165.38	0.88	250	124.38	0.80	283	194.31	0.86

APPENDIX B: Raw Data

Treatment 1

Day	0			7			14			21			28			35			42		
Sample	**M(g)**	**L(mm)**	**Cf**	**M(g)**	**L(mm)**	**Cf**	**M(g)**	**L(mm)**	**Cf**	**M(g)**	**L(mm)**	**Cf**	**M(g)**	**L(mm)**	**Cf**	**M(g)**	**L(mm)**	**Cf**	**M(g)**	**L(mm)**	**Cf**
1	2	60	0.93	2	60	0.93	3	76	0.68	7	95	0.82	24	142	0.84	20	140	0.73	43	172	0.85
2	2	58	1.03	4	80	0.78	10	105	0.86	4	82	0.73	11	106	0.92	28	155	0.75	47	175	0.88
3	2	61	0.88	4	82	0.73	3	64	1.14	15	122	0.83	9	105	0.78	17	131	0.76	21	140	0.77
4	2	60	0.93	2	63	0.80	13	114	0.88	18	131	0.80	22	139	0.82	10	110	0.75	14	121	0.79
5	2	60	0.93	6	90	0.82	13	113	0.90	2	65	0.73	12	110	0.90	23	142	0.80	21	138	0.80
6	2	63	0.80	4	80	0.78	11	103	1.01	17	125	0.87	13	110	0.98	19	134	0.79	31	155	0.83
7	2	57	1.08	2	60	0.93	6	85	0.98	16	121	0.90	13	118	0.79	8	104	0.71	26	143	0.89
8	2	65	0.73	1	50	0.80	5	85	0.81	1	64	0.38	13	116	0.83	7	98	0.74	25	142	0.87
9	3	73	0.77	1	48	0.90	3	70	0.87	18	126	0.90	7	89	0.99	19	134	0.79	18	120	1.04
10	4	80	0.78	2	62	0.84	5	85	0.81	4	88	0.59	15	122	0.83	20	138	0.76	24	140	0.87
11	1	50	0.80	2	61	0.88	7	91	0.93	1	60	0.46	11	111	0.80	39	167	0.84	32	156	0.84
12	1	48	0.90	3	71	0.84	5	86	0.79	2	75	0.47	10	107	0.82	9	110	0.68	20	133	0.85
13	2	60	0.93	5	87	0.76	3	67	1.00	5	86	0.79	18	130	0.82	11	111	0.80	15	125	0.77
14	1	50	0.80	2	62	0.84	2	64	0.76	7	96	0.79	13	115	0.85	16	129	0.75	19	130	0.86
15	2	60	0.93	1	50	0.80	1	54	0.64	6	91	0.80	17	128	0.81	21	143	0.72	13	116	0.83
16	1	53	0.67	3	70	0.87	1	52	0.71	9	98	0.96	9	105	0.78	20	132	0.87	12	114	0.81
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	31	157	0.80	26	146	0.84	65	192	0.92	25	138	0.95	56	190	0.82	110	228	0.93	50	169	1.04
2	19	135	0.77	24	142	0.84	45	175	0.84	38	165	0.85	55	187	0.84	87	210	0.94	70	200	0.88
3	28	151	0.81	17	132	0.74	38	167	0.82	62	191	0.89	57	190	0.83	47	178	0.83	60	192	0.85
4	12	114	0.81	47	171	0.94	24	137	0.93	77	206	0.88	67	199	0.85	106	225	0.93	90	216	0.89
5	43	172	0.85	27	148	0.83	51	180	0.87	41	170	0.83	79	211	0.84	63	191	0.90	99	225	0.87
6	47	180	0.81	15	120	0.87	56	187	0.86	47	175	0.88	57	189	0.84	44	175	0.82	100	230	0.82
7	20	137	0.78	31	154	0.85	33	157	0.85	56	181	0.94	40	168	0.84	50	178	0.89	100	230	0.82
8	24	142	0.84	30	152	0.85	51	181	0.86	62	182	1.03	76	217	0.74	77	205	0.89	68	198	0.88
9	25	146	0.80	36	156	0.95	48	178	0.85	72	201	0.89	60	192	0.85	48	179	0.84	90	218	0.87
10	18	133	0.77	60	187	0.92	47	176	0.86	29	140	1.06	55	176	1.01	56	185	0.88	80	209	0.88
11	30	155	0.81	47	170	0.96	28	140	1.02	23	135	0.93	67	197	0.88	78	205	0.91	79	208	0.88
12	17	121	0.96	35	160	0.85	30	154	0.82	51	180	0.87	56	184	0.90	45	176	0.83	85	214	0.87
13	35	157	0.90	46	158	1.17	27	147	0.85	32	158	0.81	37	165	0.82	45	175	0.84	87	217	0.85
14	19	135	0.77	23	140	0.84	30	154	0.82	52	181	0.88	51	186	0.79	39	170	0.79	48	177	0.87
15	43	171	0.86	34	159	0.85	23	135	0.93	82	215	0.83	29	149	0.88	46	177	0.83	85	206	0.97
16	12	113	0.83	24	146	0.77	24	136	0.95	30	155	0.81	33	156	0.87	97	218	0.94	91	220	0.85

Continued

Treatment 1																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	88	217	0.86	100	225	0.88	103	233	0.81	100	230	0.82	166	260	0.94	146	255	0.88
2	90	220	0.85	97	225	0.85	98	227	0.84	98	225	0.86	127	244	0.87	131	255	0.79
3	85	214	0.87	94	223	0.85	123	249	0.80	111	239	0.81	135	255	0.81	215	285	0.93
4	103	230	0.85	114	235	0.88	112	240	0.81	115	242	0.81	159	255	0.96	146	260	0.83
5	110	235	0.85	110	226	0.95	117	245	0.80	126	250	0.81	103	232	0.82	121	255	0.73
6	114	240	0.82	107	230	0.88	101	232	0.81	104	230	0.85	100	228	0.84	127	240	0.92
7	79	207	0.89	91	219	0.87	102	232	0.82	135	258	0.79	104	234	0.81	128	250	0.82
8	75	205	0.87	90	217	0.88	90	219	0.86	110	238	0.82	105	236	0.80	126	240	0.91
9	69	199	0.88	99	228	0.84	89	217	0.87	96	224	0.85	135	250	0.86	127	245	0.86
10	80	210	0.86	97	227	0.83	104	234	0.81	100	230	0.82	106	235	0.82	130	245	0.88
11	85	215	0.86	95	225	0.83	91	221	0.84	122	248	0.80	111	237	0.83	114	235	0.88
12	91	222	0.83	89	215	0.90	98	230	0.81	112	238	0.83	149	250	0.95	119	235	0.92
13	86	220	0.81	70	199	0.89	99	230	0.81	111	235	0.86	97	227	0.83	87	215	0.88
14	92	223	0.83	100	230	0.82	108	228	0.91	110	233	0.87	123	235	0.95	108	235	0.83
15	88	219	0.84	96	224	0.85	113	238	0.84	117	242	0.83	122	250	0.78	100	225	0.88
16	87	216	0.86	98	228	0.83	102	229	0.85	110	235	0.85	95	225	0.83	145	250	0.93
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	CF	**M(g)**	**L(mm)**	CF
1	118	245	0.80	140	255	0.84	128	245	0.87	235	320	0.72	150	255	0.90	133	250	0.85
2	108	228	0.91	213	295	0.83	192	277	0.90	188	280	0.86	155	262	0.86	203	299	0.76
3	101	225	0.89	91	225	0.80	231	295	0.90	132	250	0.84	151	260	0.86	120	245	0.82
4	152	260	0.86	158	265	0.85	136	252	0.85	160	270	0.81	235	310	0.79	143	262	0.80
5	125	248	0.82	140	250	0.90	110	230	0.90	127	250	0.81	139	260	0.79	120	245	0.82
6	141	260	0.80	146	259	0.84	116	250	0.74	173	280	0.79	160	265	0.86	104	235	0.80
7	209	295	0.81	133	246	0.89	158	268	0.82	116	240	0.84	158	270	0.80	172	280	0.78
8	105	230	0.86	108	238	0.80	96	224	0.85	182	275	0.88	119	245	0.81	146	275	0.70
9	129	245	0.88	110	230	0.90	124	245	0.84	105	240	0.76	164	260	0.93	182	280	0.83
10	168	275	0.81	122	238	0.90	88	220	0.83	117	250	0.75	123	245	0.84	147	252	0.92
11	96	215	0.97	113	235	0.87	152	255	0.92	103	235	0.79	129	250	0.83	229	305	0.81
12	122	245	0.83	153	260	0.87	144	265	0.77	172	260	0.98	100	230	0.82	167	278	0.78
13	166	275	0.80	116	240	0.84	170	275	0.82	101	230	0.83	154	275	0.74	230	300	0.85
14	118	240	0.85	117	242	0.83	83	195	1.12	136	255	0.82	161	265	0.87	173	280	0.79
15	124	248	0.81	119	245	0.81	123	250	0.79	140	258	0.82	156	270	0.79	108	240	0.78
16	119	240	0.86	145	255	0.87	108	235	0.83	190	288	0.80	145	260	0.82	149	267	0.78

Treatment 2																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	2	60	0.93	3	70	0.87	4	75	0.95	27	150	0.80	10	107	0.82	38	165	0.85	42	170	0.85
2	3	70	0.87	10	114	0.67	5	85	0.81	4	85	0.65	16	126	0.80	40	170	0.81	10	105	0.86
3	2	59	0.97	5	83	0.87	6	89	0.85	15	127	0.73	24	136	0.95	30	145	0.98	26	143	0.89
4	1	48	0.90	4	77	0.88	2	60	0.93	3	85	0.49	18	133	0.77	35	161	0.84	26	141	0.93
5	1	47	0.96	1	57	0.54	8	95	0.93	8	101	0.78	30	150	0.89	26	139	0.97	30	153	0.84
6	2	61	0.88	5	74	1.23	4	79	0.81	9	105	0.78	28	152	0.80	22	138	0.84	14	117	0.87
7	2	60	0.93	5	82	0.91	4	80	0.78	6	95	0.70	12	110	0.90	34	154	0.93	26	142	0.91
8	4	82	0.73	3	71	0.84	3	68	0.95	4	97	0.44	25	145	0.82	22	136	0.87	12	110	0.90
9	4	80	0.78	1	52	0.71	10	104	0.89	8	100	0.80	23	140	0.84	24	140	0.87	21	136	0.83
10	3	70	0.87	1	51	0.75	5	90	0.69	10	110	0.75	7	93	0.87	27	146	0.87	32	156	0.84
11	3	70	0.87	2	72	0.54	7	95	0.82	9	101	0.87	6	92	0.77	29	150	0.86	40	168	0.84
12	1	50	0.80	2	62	0.84	2	60	0.93	4	78	0.84	12	113	0.83	17	124	0.89	37	160	0.90
13	1	50	0.80	2	70	0.58	3	68	0.95	3	71	0.84	22	141	0.78	6	85	0.98	26	142	0.91
14	1	50	0.80	3	66	1.04	3	76	0.68	3	65	1.09	8	99	0.82	25	140	0.91	14	117	0.87
15	1	50	0.80	2	57	1.08	3	73	0.77	5	84	0.84	10	106	0.84	16	122	0.88	18	130	0.82
16	2	60	0.93	2	49	1.70	3	70	0.87	10	111	0.73	20	132	0.87	13	116	0.83	40	170	0.81
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	23	145	0.75	28	150	0.83	33	156	0.87	45	174	0.85	46	170	0.94	53	184	0.85	70	201	0.86
2	69	201	0.85	35	161	0.84	39	165	0.87	72	201	0.89	66	195	0.89	90	216	0.89	77	207	0.87
3	17	130	0.77	34	159	0.85	46	175	0.86	30	152	0.85	36	164	0.82	85	206	0.97	80	210	0.86
4	38	168	0.80	33	160	0.81	67	298	0.25	27	145	0.89	37	167	0.79	72	200	0.90	78	208	0.87
5	59	188	0.89	42	174	0.80	36	160	0.88	66	196	0.88	68	197	0.89	78	205	0.91	90	220	0.85
6	37	166	0.81	33	160	0.81	25	139	0.93	59	190	0.86	102	226	0.88	65	193	0.90	56	185	0.88
7	25	146	0.80	46	168	0.97	30	153	0.84	51	189	0.76	64	193	0.89	55	186	0.85	87	215	0.88
8	40	170	0.81	66	201	0.81	62	189	0.92	35	162	0.82	68	192	0.96	96	220	0.90	74	205	0.86
9	11	111	0.80	18	133	0.77	53	184	0.85	80	202	0.97	45	172	0.88	75	205	0.87	75	205	0.87
10	45	175	0.84	49	180	0.84	46	176	0.84	65	201	0.80	49	175	0.91	81	204	0.95	81	211	0.86
11	39	167	0.84	57	190	0.83	60	190	0.87	52	181	0.88	59	183	0.96	98	222	0.90	82	213	0.85
12	36	162	0.85	38	172	0.75	25	138	0.95	48	176	0.88	34	156	0.90	46	180	0.79	75	206	0.86
13	16	118	0.97	38	171	0.76	34	160	0.83	51	183	0.83	47	173	0.91	56	190	0.82	71	201	0.87
14	53	185	0.84	36	162	0.85	41	171	0.82	36	166	0.79	35	159	0.87	54	187	0.83	86	216	0.85
15	30	155	0.81	41	171	0.82	30	154	0.82	43	173	0.83	40	170	0.81	80	210	0.86	84	213	0.87
16	18	133	0.77	27	148	0.83	22	137	0.86	44	175	0.82	94	220	0.88	96	220	0.90	66	197	0.86

Continued

Treatment 2																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	97	227	0.83	99	227	0.85	104	234	0.81	96	227	0.82	115	240	0.83	171	265	0.92
2	98	228	0.83	113	240	0.82	99	228	0.84	118	246	0.79	123	245	0.84	169	273	0.83
3	96	225	0.84	120	250	0.77	115	243	0.80	110	240	0.80	122	248	0.80	79	205	0.92
4	100	231	0.81	126	254	0.77	105	234	0.82	115	244	0.79	120	248	0.79	124	240	0.90
5	89	216	0.88	106	235	0.82	105	235	0.81	122	250	0.78	150	272	0.75	187	280	0.85
6	104	230	0.85	90	220	0.85	100	230	0.82	119	247	0.79	197	283	0.87	144	250	0.92
7	99	230	0.81	89	216	0.88	110	238	0.82	111	240	0.80	146	265	0.78	202	285	0.87
8	101	231	0.82	78	208	0.87	111	238	0.82	118	244	0.81	135	253	0.83	151	250	0.97
9	96	225	0.84	84	215	0.85	97	226	0.84	120	248	0.79	95	223	0.86	119	236	0.91
10	89	218	0.86	94	224	0.84	98	227	0.84	118	245	0.80	84	213	0.87	133	245	0.90
11	95	225	0.83	126	255	0.76	112	240	0.81	140	265	0.75	132	250	0.84	130	250	0.83
12	110	240	0.80	99	228	0.84	108	236	0.82	109	238	0.81	108	236	0.82	96	225	0.84
13	99	229	0.82	98	226	0.85	106	235	0.82	124	250	0.79	142	254	0.87	158	275	0.76
14	96	227	0.82	104	233	0.82	103	233	0.81	116	243	0.81	131	249	0.85	131	248	0.86
15	89	218	0.86	87	215	0.88	101	230	0.83	138	257	0.81	152	270	0.77	113	240	0.82
16	90	220	0.85	79	205	0.92	108	237	0.81	117	244	0.81	66	196	0.88	121	238	0.90
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	CF	**M(g)**	**L(mm)**	CF
1	98	215	0.99	98	215	0.99	180	270	0.91	115	245	0.78	133	255	0.80	116	242	0.82
2	139	260	0.79	139	260	0.79	163	270	0.83	125	242	0.88	154	260	0.88	156	265	0.84
3	132	245	0.90	132	245	0.90	158	260	0.90	173	272	0.86	121	240	0.88	140	250	0.90
4	117	235	0.90	117	235	0.90	139	255	0.84	131	253	0.81	110	230	0.90	242	307	0.84
5	146	252	0.91	146	252	0.91	174	275	0.84	147	265	0.79	141	260	0.80	122	237	0.92
6	149	265	0.80	149	265	0.80	181	278	0.84	130	245	0.88	190	280	0.87	234	310	0.79
7	115	245	0.78	115	245	0.78	157	268	0.82	138	255	0.83	113	230	0.93	256	260	1.46
8	151	255	0.91	151	255	0.91	152	265	0.82	208	295	0.81	193	275	0.93	225	302	0.82
9	126	240	0.91	126	240	0.91	118	235	0.91	188	275	0.90	108	230	0.89	126	242	0.89
10	140	255	0.84	140	255	0.84	173	275	0.83	114	250	0.73	98	225	0.86	154	264	0.84
11	129	248	0.85	129	248	0.85	143	245	0.97	241	290	0.99	233	302	0.85	285	324	0.84
12	123	255	0.74	123	255	0.74	142	240	1.03	116	250	0.74	119	240	0.86	122	250	0.78
13	148	260	0.84	148	260	0.84	128	245	0.87	132	245	0.90	155	260	0.88	108	250	0.69
14	151	260	0.86	151	260	0.86	121	245	0.82	115	220	1.08	195	290	0.80	155	255	0.93
15	121	235	0.93	121	235	0.93	125	240	0.90	170	260	0.97	189	285	0.82	109	235	0.84
16	254	310	0.85	254	310	0.85	133	250	0.85	161	270	0.82	163	280	0.74	114	240	0.82

Continued

Treatment 3																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	2	60	0.93	3	70	0.87	13	105	1.12	14	122	0.77	13	115	0.85	18	131	0.80	46	177	0.83
2	2	60	0.93	3	70	0.87	10	100	1.00	4	84	0.67	11	114	0.74	27	147	0.85	34	157	0.88
3	2	60	0.93	4	80	0.78	11	105	0.95	15	118	0.91	32	157	0.83	25	142	0.87	27	143	0.92
4	3	75	0.71	5	85	0.81	2	67	0.66	22	137	0.86	15	124	0.79	37	165	0.82	24	140	0.87
5	2	65	0.73	8	95	0.93	5	79	1.01	8	100	0.80	16	126	0.80	24	140	0.87	21	136	0.83
6	1	50	0.80	6	90	0.82	2	55	1.20	21	131	0.93	35	157	0.90	29	144	0.97	41	175	0.77
7	1	55	0.60	5	83	0.87	7	92	0.90	4	82	0.73	31	154	0.85	8	99	0.82	19	132	0.83
8	1	50	0.80	3	68	0.95	2	59	0.97	4	83	0.70	12	112	0.85	25	145	0.82	30	153	0.84
9	2	63	0.80	2	58	1.03	3	74	0.74	4	83	0.70	19	126	0.95	9	104	0.80	23	137	0.89
10	3	74	0.74	2	59	0.97	4	75	0.95	22	130	1.00	13	119	0.77	17	125	0.87	26	143	0.89
11	3	72	0.80	1	47	0.96	3	70	0.87	10	113	0.69	12	116	0.77	18	129	0.84	32	156	0.84
12	1	47	0.96	1	45	1.10	6	90	0.82	2	65	0.73	9	104	0.80	17	125	0.87	39	164	0.88
13	1	45	1.10	2	60	0.93	2	67	0.66	13	121	0.73	13	115	0.85	17	124	0.89	31	155	0.83
14	4	90	0.55	3	70	0.87	2	59	0.97	12	119	0.71	14	117	0.87	26	144	0.87	33	157	0.85
15	2	55	1.20	2	60	0.93	4	75	0.95	11	115	0.72	18	130	0.82	41	171	0.82	34	158	0.86
16	2	58	1.03	4	76	0.91	3	68	0.95	6	91	0.80	18	129	0.84	6	89	0.85	44	176	0.81
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	23	145	0.75	34	159	0.85	42	173	0.81	55	182	0.91	63	190	0.92	93	218	0.90	105	235	0.81
2	43	171	0.86	18	127	0.88	81	228	0.68	64	197	0.84	47	177	0.85	34	164	0.77	90	221	0.83
3	41	170	0.83	29	145	0.95	20	130	0.91	66	200	0.83	36	167	0.77	91	212	0.96	120	245	0.82
4	69	205	0.80	22	138	0.84	40	168	0.84	59	191	0.85	43	172	0.85	70	200	0.88	109	238	0.81
5	50	180	0.86	34	160	0.83	57	188	0.86	52	185	0.82	67	197	0.88	64	190	0.93	88	218	0.85
6	33	156	0.87	42	174	0.80	51	181	0.86	34	158	0.86	52	180	0.89	80	210	0.86	106	235	0.82
7	41	170	0.83	27	146	0.87	25	143	0.85	32	157	0.83	45	175	0.84	87	208	0.97	91	220	0.85
8	10	113	0.69	23	138	0.88	34	160	0.83	28	149	0.85	72	196	0.96	55	174	1.04	84	214	0.86
9	30	155	0.81	56	187	0.86	46	175	0.86	51	186	0.79	89	216	0.88	55	175	1.03	82	213	0.85
10	40	168	0.84	74	203	0.88	28	147	0.88	33	158	0.84	37	168	0.78	53	182	0.88	79	208	0.88
11	43	172	0.85	52	185	0.82	41	172	0.81	57	183	0.93	63	191	0.90	47	175	0.88	78	206	0.89
12	19	133	0.81	46	175	0.86	30	150	0.89	46	158	1.17	39	164	0.88	58	180	0.99	80	210	0.86
13	39	167	0.84	25	148	0.77	22	139	0.82	35	160	0.85	38	162	0.89	81	210	0.87	81	209	0.89
14	31	158	0.79	18	127	0.88	66	204	0.78	26	146	0.84	108	225	0.95	74	195	1.00	86	215	0.87
15	10	111	0.73	53	180	0.91	20	135	0.81	20	130	0.91	67	185	1.06	53	183	0.86	87	216	0.86
16	9	105	0.78	16	124	0.84	30	146	0.96	20	132	0.87	27	148	0.83	88	213	0.91	79	209	0.87

Continued

Treatment 3																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	103	230	0.85	112	240	0.81	110	240	0.80	122	235	0.94	111	240	0.80	126	247	0.84
2	131	254	0.80	123	235	0.95	114	230	0.94	108	235	0.83	107	236	0.81	156	257	0.92
3	114	243	0.79	113	225	0.99	126	240	0.91	133	240	0.96	116	244	0.80	115	232	0.92
4	109	239	0.80	104	233	0.82	118	245	0.80	86	215	0.87	123	235	0.95	115	240	0.83
5	112	240	0.81	100	229	0.83	98	227	0.84	94	223	0.85	118	230	0.97	121	235	0.93
6	99	228	0.84	98	225	0.86	107	235	0.82	123	250	0.79	119	230	0.98	156	270	0.79
7	96	225	0.84	114	230	0.94	120	245	0.82	110	240	0.80	99	228	0.84	92	220	0.86
8	89	217	0.87	126	235	0.97	113	240	0.82	153	275	0.74	125	233	0.99	156	255	0.94
9	104	233	0.82	110	240	0.80	134	240	0.97	87	215	0.88	127	250	0.81	93	225	0.82
10	92	222	0.84	106	236	0.81	94	222	0.86	100	230	0.82	108	237	0.81	153	268	0.79
11	104	234	0.81	124	245	0.84	123	245	0.84	128	255	0.77	117	244	0.81	118	245	0.80
12	101	230	0.83	117	245	0.80	114	240	0.82	99	225	0.87	113	240	0.82	83	210	0.90
13	99	228	0.84	112	230	0.92	116	242	0.82	200	290	0.82	109	237	0.82	170	270	0.86
14	108	235	0.83	109	235	0.84	112	240	0.81	96	220	0.90	156	265	0.84	96	225	0.84
15	103	234	0.80	116	239	0.85	111	238	0.82	103	230	0.85	130	240	0.94	109	230	0.90
16	98	227	0.84	106	234	0.83	120	235	0.92	135	253	0.83	139	260	0.79	98	230	0.81
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	157	265	0.84	104	233	0.82	171	265	0.92	139	245	0.95	112	235	0.86	129	250	0.83
2	246	300	0.91	158	270	0.80	223	312	0.73	118	242	0.83	107	230	0.88	103	220	0.97
3	130	240	0.94	110	228	0.93	209	300	0.77	137	250	0.88	235	298	0.89	151	250	0.97
4	86	215	0.87	131	240	0.95	128	245	0.87	162	260	0.92	130	250	0.83	170	266	0.90
5	179	270	0.91	125	245	0.85	149	257	0.88	136	260	0.77	253	298	0.96	141	255	0.85
6	97	230	0.80	144	260	0.82	115	240	0.83	127	240	0.92	113	235	0.87	196	280	0.89
7	156	260	0.89	176	280	0.80	118	245	0.80	113	240	0.82	227	290	0.93	129	250	0.83
8	114	230	0.94	149	265	0.80	148	252	0.92	100	220	0.94	109	240	0.79	222	290	0.91
9	120	240	0.87	154	266	0.82	146	260	0.83	181	284	0.79	148	270	0.75	197	285	0.85
10	170	270	0.86	177	278	0.82	108	215	1.09	202	293	0.80	112	245	0.76	149	250	0.95
11	136	248	0.89	131	254	0.80	141	255	0.85	162	270	0.82	87	220	0.82	128	251	0.81
12	86	217	0.84	130	251	0.82	151	265	0.81	111	225	0.97	125	250	0.80	152	257	0.90
13	141	244	0.97	125	230	1.03	121	250	0.77	168	265	0.90	125	245	0.85	144	260	0.82
14	101	246	0.68	126	235	0.97	110	228	0.93	123	238	0.91	157	270	0.80	164	270	0.83
15	146	259	0.84	123	240	0.89	109	230	0.90	189	270	0.96	118	240	0.85	129	250	0.83
16	155	266	0.82	173	267	0.91	118	235	0.91	137	255	0.83	172	262	0.96	219	297	0.84

Continued

Treatment 4																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	2	62	0.84	3	68	0.95	12	116	0.77	4	82	0.73	14	120	0.81	33	156	0.87	35	160	0.85
2	2	63	0.80	3	70	0.87	8	114	0.54	28	152	0.80	10	108	0.79	34	165	0.76	44	176	0.81
3	2	61	0.88	4	73	1.03	3	79	0.61	4	84	0.67	15	120	0.87	25	143	0.85	51	177	0.92
4	2	60	0.93	6	84	1.01	5	90	0.69	7	100	0.70	12	114	0.81	4	83	0.70	25	142	0.87
5	2	60	0.93	9	95	1.05	2	70	0.58	3	80	0.59	18	132	0.78	19	133	0.81	44	176	0.81
6	2	61	0.88	4	80	0.78	1	56	0.57	20	136	0.80	8	97	0.88	30	152	0.85	37	163	0.85
7	2	61	0.88	5	86	0.79	1	57	0.54	9	105	0.78	21	134	0.87	19	132	0.83	22	136	0.87
8	1	50	0.80	3	67	1.00	7	90	0.96	4	80	0.78	12	113	0.83	21	138	0.80	17	127	0.83
9	1	52	0.71	2	57	1.08	7	91	0.93	3	75	0.71	28	150	0.83	15	120	0.87	9	108	0.71
10	3	72	0.80	1	40	1.56	6	86	0.94	3	80	0.59	23	145	0.75	20	135	0.81	25	140	0.91
11	1	47	0.96	1	45	1.10	6	85	0.98	2	70	0.58	12	115	0.79	24	140	0.87	13	115	0.85
12	3	75	0.71	2	60	0.93	5	79	1.01	11	111	0.80	9	105	0.78	22	139	0.82	33	157	0.85
13	1	50	0.80	3	72	0.80	3	66	1.04	4	83	0.70	17	126	0.85	31	154	0.85	29	150	0.86
14	1	53	0.67	3	74	0.74	2	57	1.08	7	99	0.72	14	118	0.85	21	136	0.83	31	155	0.83
15	1	51	0.75	2	64	0.76	2	55	1.20	5	88	0.73	18	131	0.80	23	140	0.84	8	104	0.71
16	2	60	0.93	2	60	0.93	2	65	0.73	6	95	0.70	30	149	0.91	26	146	0.84	19	129	0.89
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	13	115	0.85	38	171	0.76	34	158	0.86	26	140	0.95	75	203	0.90	66	196	0.88	83	212	0.87
2	44	173	0.85	35	160	0.85	48	176	0.88	52	180	0.89	32	153	0.89	46	175	0.86	85	215	0.86
3	23	143	0.79	24	139	0.89	59	192	0.83	42	170	0.85	51	182	0.85	94	215	0.95	80	210	0.86
4	30	156	0.79	39	173	0.75	58	190	0.85	50	180	0.86	68	190	0.99	70	195	0.94	88	215	0.89
5	55	185	0.87	35	161	0.84	33	155	0.89	84	226	0.73	50	180	0.86	45	173	0.87	89	218	0.86
6	44	174	0.84	23	138	0.88	26	148	0.80	66	195	0.89	75	202	0.91	65	195	0.88	72	202	0.87
7	30	150	0.89	46	175	0.86	45	175	0.84	69	202	0.84	99	214	1.01	66	196	0.88	70	199	0.89
8	32	154	0.88	42	176	0.77	68	200	0.85	59	190	0.86	39	165	0.87	61	190	0.89	92	220	0.86
9	45	175	0.84	32	159	0.80	56	190	0.82	36	163	0.83	104	224	0.93	40	168	0.84	94	223	0.85
10	22	140	0.80	75	220	0.70	48	177	0.87	53	184	0.85	41	168	0.86	44	174	0.84	83	213	0.86
11	27	149	0.82	26	142	0.91	40	168	0.84	36	164	0.82	83	210	0.90	65	195	0.88	79	208	0.88
12	20	134	0.83	62	191	0.89	60	194	0.82	24	135	0.98	104	215	1.05	39	170	0.79	92	220	0.86
13	41	180	0.70	40	169	0.83	33	156	0.87	36	160	0.88	61	190	0.89	66	197	0.86	69	197	0.90
14	25	146	0.80	72	213	0.75	38	165	0.85	79	210	0.85	39	160	0.95	88	214	0.90	99	298	0.37
15	45	182	0.75	18	126	0.90	36	163	0.83	36	163	0.83	47	171	0.94	106	232	0.85	73	200	0.91
16	8	107	0.65	51	178	0.90	56	185	0.88	40	168	0.84	28	145	0.92	35	165	0.78	79	209	0.87

Continued

Treatment 4																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	92	221	0.85	100	230	0.82	110	240	0.80	145	255	0.87	146	245	0.99	197	280	0.90
2	90	220	0.85	87	215	0.88	121	250	0.77	122	244	0.84	130	237	0.98	148	250	0.95
3	111	240	0.80	74	204	0.87	109	238	0.81	117	237	0.88	129	250	0.83	200	285	0.86
4	87	215	0.88	108	236	0.82	101	229	0.84	120	240	0.87	129	250	0.83	151	260	0.86
5	88	215	0.89	119	246	0.80	99	229	0.82	125	245	0.85	126	248	0.83	151	255	0.91
6	76	205	0.88	100	230	0.82	134	260	0.76	131	252	0.82	128	251	0.81	88	215	0.89
7	120	248	0.79	109	236	0.83	114	240	0.82	118	238	0.88	134	240	0.97	80	220	0.75
8	101	230	0.83	124	250	0.79	106	235	0.82	120	237	0.90	136	240	0.98	116	237	0.87
9	94	223	0.85	107	235	0.82	110	240	0.80	116	240	0.84	140	255	0.84	108	230	0.89
10	98	227	0.84	104	233	0.82	111	240	0.80	115	238	0.85	126	250	0.81	122	240	0.88
11	88	217	0.86	92	222	0.84	117	243	0.82	125	250	0.80	120	245	0.82	144	265	0.77
12	79	210	0.85	98	226	0.85	104	230	0.85	123	247	0.82	119	239	0.87	156	265	0.84
13	92	222	0.84	111	239	0.81	100	229	0.83	126	250	0.81	132	250	0.84	90	215	0.91
14	98	228	0.83	104	234	0.81	106	234	0.83	130	250	0.83	129	253	0.80	137	260	0.78
15	89	218	0.86	116	245	0.79	112	242	0.79	128	248	0.84	124	248	0.81	93	225	0.82
16	79	205	0.92	115	243	0.80	118	245	0.80	112	239	0.82	128	240	0.93	145	260	0.82
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	177	273	0.87	127	245	0.86	145	252	0.91	181	290	0.74	153	260	0.87	116	250	0.74
2	122	243	0.85	153	265	0.82	111	234	0.87	110	238	0.82	144	255	0.87	148	270	0.75
3	112	230	0.92	128	252	0.80	207	295	0.81	165	270	0.84	222	300	0.82	120	260	0.68
4	123	245	0.84	177	277	0.83	109	228	0.92	100	233	0.79	129	255	0.78	177	275	0.85
5	159	270	0.81	107	222	0.98	127	248	0.83	171	272	0.85	164	278	0.76	123	243	0.86
6	123	240	0.89	110	237	0.83	119	237	0.89	121	250	0.77	152	270	0.77	217	290	0.89
7	115	232	0.92	150	260	0.85	95	222	0.87	110	230	0.90	170	270	0.86	292	325	0.85
8	101	230	0.83	176	273	0.87	164	264	0.89	123	245	0.84	100	235	0.77	122	250	0.78
9	151	251	0.95	148	250	0.95	161	260	0.92	118	245	0.80	99	225	0.87	168	282	0.75
10	105	230	0.86	216	300	0.80	144	250	0.92	165	275	0.79	158	260	0.90	222	300	0.82
11	114	247	0.76	114	240	0.82	162	273	0.80	219	308	0.75	165	265	0.89	159	280	0.72
12	111	237	0.83	157	265	0.84	110	233	0.87	102	225	0.90	189	275	0.91	115	240	0.83
13	127	257	0.75	112	235	0.86	120	241	0.86	103	230	0.85	109	230	0.90	193	290	0.79
14	210	308	0.72	123	245	0.84	112	235	0.86	169	275	0.81	144	260	0.82	142	255	0.86
15	189	274	0.92	84	215	0.85	167	270	0.85	162	260	0.92	169	270	0.86	258	315	0.83
16	115	213	1.19	86	217	0.84	171	274	0.83	130	250	0.83	116	235	0.89	163	275	0.78

Continued

Treatment 5																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	2	60	0.93	3	70	0.87	3	70	0.87	30	150	0.89	23	138	0.88	8	98	0.85	40	171	0.80
2	2	65	0.73	4	80	0.78	3	69	0.91	14	116	0.90	11	111	0.80	19	134	0.79	27	143	0.92
3	2	70	0.58	10	110	0.75	1	58	0.51	9	102	0.85	18	133	0.77	24	145	0.79	19	130	0.86
4	1	52	0.71	6	90	0.82	8	100	0.80	10	105	0.86	15	124	0.79	13	116	0.83	33	157	0.85
5	1	51	0.75	8	98	0.85	12	108	0.95	19	128	0.91	24	140	0.87	9	105	0.78	46	178	0.82
6	3	70	0.87	4	77	0.88	13	116	0.83	9	102	0.85	11	110	0.83	27	146	0.87	31	158	0.79
7	3	75	0.71	5	87	0.76	16	124	0.84	12	112	0.85	20	136	0.80	15	119	0.89	25	140	0.91
8	4	80	0.78	4	79	0.81	15	116	0.96	15	119	0.89	18	133	0.77	22	136	0.87	17	129	0.79
9	1	53	0.67	4	78	0.84	2	72	0.54	6	86	0.94	15	125	0.77	25	147	0.79	29	153	0.81
10	1	50	0.80	3	68	0.95	6	90	0.82	12	110	0.90	24	140	0.87	26	148	0.80	17	128	0.81
11	2	60	0.93	2	60	0.93	6	92	0.77	11	105	0.95	8	101	0.78	24	140	0.87	14	117	0.87
12	2	60	0.93	4	80	0.78	2	66	0.70	1	64	0.38	20	132	0.87	15	117	0.94	24	138	0.91
13	2	60	0.93	4	81	0.75	8	113	0.55	4	78	0.84	22	136	0.87	24	142	0.84	21	136	0.83
14	1	50	0.80	4	82	0.73	1	50	0.80	4	79	0.81	13	122	0.72	5	85	0.81	11	111	0.80
15	1	46	1.03	2	63	0.80	3	69	0.91	4	75	0.95	30	151	0.87	27	151	0.78	30	152	0.85
16	2	58	1.03	3	68	0.95	1	60	0.46	2	65	0.73	7	95	0.82	32	157	0.83	41	175	0.77
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	26	125	1.33	33	156	0.87	41	160	1.00	42	174	0.80	50	175	0.93	70	200	0.88	88	216	0.87
2	30	152	0.85	31	153	0.87	32	154	0.88	40	167	0.86	62	193	0.86	73	202	0.89	132	240	0.95
3	10	111	0.73	34	160	0.83	26	142	0.91	60	190	0.87	29	148	0.89	50	180	0.86	72	205	0.84
4	54	186	0.84	14	117	0.87	43	170	0.88	40	168	0.84	62	194	0.85	65	195	0.88	66	197	0.86
5	18	127	0.88	61	190	0.89	48	176	0.88	49	180	0.84	49	178	0.87	53	184	0.85	106	230	0.87
6	54	185	0.85	41	171	0.82	51	182	0.85	47	177	0.85	39	159	0.97	71	200	0.89	83	208	0.92
7	19	130	0.86	34	158	0.86	42	171	0.84	71	204	0.84	59	189	0.87	56	186	0.87	45	176	0.83
8	27	147	0.85	48	181	0.81	22	135	0.89	46	175	0.86	64	196	0.85	64	194	0.88	95	200	1.19
9	80	197	1.05	55	186	0.85	46	172	0.90	50	172	0.98	45	165	1.00	77	206	0.88	59	190	0.86
10	41	171	0.82	7	96	0.79	40	165	0.89	39	167	0.84	63	192	0.89	50	182	0.83	50	180	0.86
11	24	139	0.89	15	119	0.89	24	138	0.91	40	162	0.94	75	207	0.85	49	178	0.87	44	174	0.84
12	26	142	0.91	36	168	0.76	35	160	0.85	36	162	0.85	50	183	0.82	58	188	0.87	62	200	0.78
13	15	120	0.87	32	155	0.86	42	168	0.89	28	150	0.83	47	176	0.86	60	190	0.87	71	203	0.85
14	34	160	0.83	22	139	0.82	40	165	0.89	40	168	0.84	46	174	0.87	72	202	0.87	35	167	0.75
15	13	118	0.79	35	160	0.85	28	148	0.86	35	162	0.82	30	150	0.89	82	212	0.86	43	174	0.82
16	8	103	0.73	29	152	0.83	20	134	0.83	22	130	1.00	26	145	0.85	71	201	0.87	78	208	0.87

Continued

Treatment 5																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	71	201	0.87	103	230	0.85	99	228	0.84	160	265	0.86	101	229	0.84	182	285	0.79
2	68	199	0.86	112	240	0.81	121	230	0.99	118	236	0.90	98	228	0.83	137	260	0.78
3	74	204	0.87	117	243	0.82	105	233	0.83	118	240	0.85	111	239	0.81	159	270	0.81
4	63	195	0.85	123	235	0.95	100	230	0.82	90	220	0.85	110	240	0.80	107	234	0.84
5	89	216	0.88	101	230	0.83	92	222	0.84	106	240	0.77	119	245	0.81	109	237	0.82
6	70	199	0.89	95	225	0.83	96	224	0.85	113	234	0.88	122	250	0.78	128	255	0.77
7	62	190	0.90	90	220	0.85	115	243	0.80	129	255	0.78	115	243	0.80	115	245	0.78
8	72	200	0.90	104	231	0.84	102	232	0.82	97	225	0.85	114	243	0.79	131	260	0.75
9	71	200	0.89	91	219	0.87	110	240	0.80	57	195	0.77	116	245	0.79	97	225	0.85
10	64	194	0.88	98	228	0.83	112	241	0.80	101	235	0.78	118	245	0.80	146	260	0.83
11	78	208	0.87	103	233	0.81	120	230	0.99	81	215	0.82	119	247	0.79	157	275	0.75
12	88	218	0.85	102	232	0.82	117	244	0.81	113	240	0.82	120	249	0.78	162	275	0.78
13	59	188	0.89	99	228	0.84	90	220	0.85	94	220	0.88	113	243	0.79	91	220	0.85
14	72	201	0.89	102	232	0.82	101	231	0.82	80	205	0.93	127	256	0.76	110	238	0.82
15	71	200	0.89	99	228	0.84	105	233	0.83	148	265	0.80	112	243	0.78	94	224	0.84
16	69	199	0.88	112	240	0.81	95	224	0.85	115	240	0.83	109	238	0.81	88	218	0.85
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	104	225	0.91	105	235	0.81	93	225	0.82	121	236	0.92	148	260	0.84	158	275	0.76
2	144	265	0.77	121	245	0.82	147	260	0.84	101	225	0.89	168	270	0.85	173	275	0.83
3	155	260	0.88	119	235	0.92	104	230	0.85	126	245	0.86	150	260	0.85	192	295	0.75
4	114	245	0.78	302	362	0.64	121	247	0.80	123	240	0.89	136	243	0.95	250	316	0.79
5	124	240	0.90	231	290	0.95	94	225	0.83	228	314	0.74	162	259	0.93	173	273	0.85
6	106	235	0.82	140	260	0.80	232	300	0.86	257	320	0.78	135	248	0.89	106	245	0.72
7	137	250	0.88	126	250	0.81	126	250	0.81	145	260	0.82	142	263	0.78	240	307	0.83
8	122	248	0.80	142	255	0.86	163	265	0.88	117	250	0.75	141	260	0.80	112	250	0.72
9	145	253	0.90	135	240	0.98	115	235	0.89	183	280	0.83	148	265	0.80	123	255	0.74
10	118	240	0.85	119	240	0.86	205	285	0.89	179	282	0.80	94	225	0.83	216	305	0.76
11	225	290	0.92	146	250	0.93	183	295	0.71	123	249	0.80	99	230	0.81	109	242	0.77
12	112	240	0.81	119	243	0.83	144	255	0.87	126	245	0.86	220	300	0.81	121	250	0.77
13	141	255	0.85	90	220	0.85	106	230	0.87	111	235	0.86	242	295	0.94	166	275	0.80
14	128	245	0.87	144	252	0.90	88	220	0.83	115	240	0.83	123	246	0.83	108	240	0.78
15	101	230	0.83	128	250	0.82	106	235	0.82	105	235	0.81	100	230	0.82	116	240	0.84
16	250	290	1.03	84	215	0.85	227	305	0.80	100	230	0.82	183	270	0.93	129	252	0.81

Continued

Treatment 6																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	1	45	1.10	4	75	0.95	12	114	0.81	9	103	0.82	19	127	0.93	12	111	0.88	26	143	0.89
2	1	46	1.03	10	104	0.89	3	79	0.61	9	102	0.85	20	132	0.87	22	137	0.86	32	156	0.84
3	2	60	0.93	8	100	0.80	9	104	0.80	16	125	0.82	14	118	0.85	19	136	0.76	23	137	0.89
4	3	70	0.87	6	90	0.82	1	50	0.80	13	112	0.93	18	129	0.84	24	147	0.76	28	148	0.86
5	2	58	1.03	5	84	0.84	4	84	0.67	2	62	0.84	19	134	0.79	38	163	0.88	22	137	0.86
6	3	73	0.77	6	89	0.85	15	123	0.81	2	65	0.73	21	135	0.85	25	145	0.82	27	146	0.87
7	2	64	0.76	7	90	0.96	4	81	0.75	4	79	0.81	10	106	0.84	8	105	0.69	36	161	0.86
8	2	62	0.84	12	108	0.95	4	83	0.70	21	131	0.93	18	135	0.73	23	140	0.84	39	158	0.99
9	2	60	0.93	2	60	0.93	1	50	0.80	4	75	0.95	22	137	0.86	22	142	0.77	20	132	0.87
10	1	50	0.80	3	70	0.87	10	108	0.79	5	90	0.69	11	108	0.87	24	146	0.77	18	120	1.04
11	1	47	0.96	3	70	0.87	4	80	0.78	3	66	1.04	13	117	0.81	23	138	0.88	33	157	0.85
12	2	60	0.93	6	85	0.98	15	120	0.87	11	109	0.85	8	97	0.88	12	113	0.83	43	172	0.85
13	2	65	0.73	5	80	0.98	4	78	0.84	2	65	0.73	13	113	0.90	20	136	0.80	26	143	0.89
14	2	58	1.03	5	80	0.98	6	92	0.77	9	105	0.78	14	120	0.81	11	111	0.80	39	160	0.95
15	2	59	0.97	4	74	0.99	1	51	0.75	11	107	0.90	11	111	0.80	11	110	0.83	40	160	0.98
16	2	62	0.84	7	95	0.82	1	50	0.80	4	80	0.78	19	135	0.77	14	119	0.83	37	157	0.96
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	23	143	0.79	30	150	0.89	51	180	0.87	50	174	0.95	59	180	1.01	69	193	0.96	66	196	0.88
2	39	165	0.87	17	125	0.87	36	161	0.86	46	175	0.86	60	184	0.96	68	192	0.96	67	196	0.89
3	34	155	0.91	34	158	0.86	45	170	0.92	42	175	0.78	71	203	0.85	67	195	0.90	84	214	0.86
4	27	150	0.80	17	125	0.87	48	176	0.88	62	194	0.85	64	191	0.92	63	193	0.88	54	185	0.85
5	49	178	0.87	63	193	0.88	49	178	0.87	42	172	0.83	35	156	0.92	56	186	0.87	59	188	0.89
6	28	150	0.83	38	170	0.77	50	181	0.84	35	160	0.85	45	170	0.92	102	225	0.90	60	189	0.89
7	45	174	0.85	59	190	0.86	60	193	0.83	44	176	0.81	67	195	0.90	66	195	0.89	72	200	0.90
8	28	151	0.81	20	130	0.91	39	168	0.82	54	191	0.77	45	171	0.90	76	207	0.86	76	205	0.88
9	60	190	0.87	40	170	0.81	38	166	0.83	44	180	0.75	57	195	0.77	73	203	0.87	81	210	0.87
10	37	167	0.79	34	158	0.86	34	155	0.91	37	161	0.89	41	166	0.90	58	189	0.86	78	208	0.87
11	8	103	0.73	45	175	0.84	25	138	0.95	32	158	0.81	36	165	0.80	61	189	0.90	66	196	0.88
12	54	183	0.88	30	151	0.87	30	150	0.89	29	149	0.88	79	208	0.88	65	190	0.95	56	187	0.86
13	47	175	0.88	25	141	0.89	26	136	1.03	33	159	0.82	44	169	0.91	66	198	0.85	58	188	0.87
14	18	134	0.75	25	140	0.91	20	130	0.91	29	145	0.95	44	168	0.93	54	185	0.85	62	190	0.90
15	8	103	0.73	20	130	0.91	25	135	1.02	25	148	0.77	64	192	0.90	69	202	0.84	70	200	0.88
16	8	103	0.73	34	158	0.86	21	132	0.91	27	143	0.92	17	126	0.85	64	196	0.85	59	190	0.86

Continued

Treatment 6																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	74	204	0.87	83	210	0.90	90	220	0.85	100	230	0.82	139	255	0.84	151	280	0.69
2	69	199	0.88	80	208	0.89	100	229	0.83	78	215	0.78	135	255	0.81	140	268	0.73
3	76	206	0.87	78	205	0.91	98	227	0.84	105	235	0.81	169	270	0.86	108	238	0.80
4	72	200	0.90	95	220	0.89	112	242	0.79	90	219	0.86	96	235	0.74	85	213	0.88
5	82	211	0.87	75	205	0.87	105	235	0.81	84	214	0.86	96	230	0.79	123	243	0.86
6	72	202	0.87	88	215	0.89	96	226	0.83	104	233	0.82	84	210	0.91	78	207	0.88
7	71	200	0.89	79	209	0.87	99	229	0.82	116	244	0.80	124	240	0.90	92	220	0.86
8	69	199	0.88	80	210	0.86	98	228	0.83	121	249	0.78	98	225	0.86	146	270	0.74
9	84	210	0.91	74	203	0.88	89	228	0.75	110	240	0.80	51	180	0.87	138	265	0.74
10	86	214	0.88	86	215	0.87	92	222	0.84	102	231	0.83	100	240	0.72	96	225	0.84
11	59	188	0.89	92	220	0.86	97	226	0.84	105	233	0.83	133	250	0.85	156	280	0.71
12	76	200	0.95	84	214	0.86	99	228	0.84	107	235	0.82	91	220	0.85	105	234	0.82
13	69	199	0.88	97	227	0.83	98	228	0.83	116	244	0.80	114	243	0.79	102	232	0.82
14	78	205	0.91	77	207	0.87	98	227	0.84	131	259	0.75	120	250	0.77	95	225	0.83
15	68	200	0.85	83	213	0.86	100	230	0.82	122	245	0.83	124	248	0.81	108	237	0.81
16	79	207	0.89	81	210	0.87	98	226	0.85	92	222	0.84	122	245	0.83	108	238	0.80
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	132	245	0.90	111	235	0.86	120	240	0.87	112	240	0.81	192	275	0.92	177	275	0.85
2	165	265	0.89	207	280	0.94	106	235	0.82	141	250	0.90	115	230	0.95	140	265	0.75
3	111	240	0.80	110	235	0.85	121	230	0.99	204	289	0.85	175	270	0.89	120	245	0.82
4	110	230	0.90	134	250	0.86	111	230	0.91	105	230	0.86	118	240	0.85	145	265	0.78
5	200	275	0.96	130	250	0.83	164	280	0.75	132	250	0.84	176	270	0.89	104	230	0.85
6	96	225	0.84	138	255	0.83	130	238	0.96	198	285	0.86	151	260	0.86	129	245	0.88
7	136	245	0.92	136	257	0.80	210	296	0.81	265	305	0.93	96	225	0.84	217	298	0.82
8	126	250	0.81	155	255	0.93	181	275	0.87	82	205	0.95	95	215	0.96	160	270	0.81
9	136	240	0.98	126	240	0.91	143	252	0.89	169	265	0.91	235	340	0.60	118	240	0.85
10	128	250	0.82	115	230	0.95	105	232	0.84	140	250	0.90	125	245	0.85	177	270	0.90
11	114	240	0.82	104	235	0.80	188	285	0.81	119	240	0.86	111	240	0.80	208	299	0.78
12	109	230	0.90	151	257	0.89	185	280	0.84	110	230	0.90	157	260	0.89	125	250	0.80
13	129	240	0.93	105	225	0.92	134	245	0.91	89	225	0.78	140	255	0.84	136	250	0.87
14	116	240	0.84	180	282	0.80	106	225	0.93	147	265	0.79	225	285	0.97	187	280	0.85
15	149	255	0.90	126	240	0.91	123	250	0.79	113	235	0.87	125	235	0.96	151	250	0.97
16	98	231	0.80	120	234	0.94	100	230	0.82	178	270	0.90	121	230	0.99	154	255	0.93

Continued

Treatment 7																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	1	50	0.80	4	80	0.78	8	95	0.93	12	113	0.83	22	140	0.80	38	162	0.89	27	146	0.87
2	1	50	0.80	3	70	0.87	16	125	0.82	17	125	0.87	13	113	0.90	18	130	0.82	23	137	0.89
3	1	52	0.71	3	70	0.87	5	85	0.81	9	101	0.87	22	136	0.87	17	126	0.85	31	158	0.79
4	2	60	0.93	2	60	0.93	9	100	0.90	17	125	0.87	16	120	0.93	30	150	0.89	28	151	0.81
5	2	65	0.73	5	87	0.76	10	105	0.86	12	115	0.79	14	118	0.85	37	160	0.90	24	138	0.91
6	3	73	0.77	5	89	0.71	2	68	0.64	16	119	0.95	15	120	0.87	5	94	0.60	20	131	0.89
7	2	58	1.03	6	90	0.82	8	100	0.80	14	115	0.92	28	151	0.81	40	168	0.84	13	125	0.67
8	2	62	0.84	4	78	0.84	7	90	0.96	10	115	0.66	16	121	0.90	32	153	0.89	32	156	0.84
9	3	72	0.80	4	79	0.81	6	86	0.94	5	85	0.81	16	123	0.86	14	117	0.87	43	172	0.85
10	1	50	0.80	8	99	0.82	3	67	1.00	20	131	0.89	7	90	0.96	7	106	0.59	32	156	0.84
11	1	52	0.71	2	60	0.93	1	50	0.80	12	115	0.79	12	110	0.90	18	132	0.78	28	150	0.83
12	1	49	0.85	1	46	1.03	2	60	0.93	2	69	0.61	18	127	0.88	17	125	0.87	14	117	0.87
13	3	70	0.87	5	90	0.69	2	60	0.93	2	70	0.58	19	130	0.86	12	113	0.83	23	138	0.88
14	2	60	0.93	4	80	0.78	3	70	0.87	1	56	0.57	16	123	0.86	17	126	0.85	26	143	0.89
15	1	50	0.80	4	80	0.78	3	70	0.87	2	64	0.76	10	105	0.86	30	151	0.87	17	126	0.85
16	3	70	0.87	5	85	0.81	2	60	0.93	4	79	0.81	6	90	0.82	32	157	0.83	17	126	0.85
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	33	164	0.75	43	173	0.83	45	170	0.92	42	170	0.85	66	195	0.89	69	199	0.88	67	198	0.86
2	39	167	0.84	23	145	0.75	60	190	0.87	72	200	0.90	42	171	0.84	108	218	1.04	72	202	0.87
3	39	166	0.85	46	175	0.86	58	186	0.90	67	195	0.90	75	210	0.81	59	193	0.82	85	215	0.86
4	25	145	0.82	50	180	0.86	39	170	0.79	66	194	0.90	56	187	0.86	78	202	0.95	57	187	0.87
5	25	145	0.82	39	170	0.79	46	179	0.80	74	206	0.85	60	193	0.83	55	183	0.90	56	185	0.88
6	44	176	0.81	45	173	0.87	32	154	0.88	61	193	0.85	55	189	0.81	58	190	0.85	90	220	0.85
7	34	156	0.90	26	145	0.85	36	162	0.85	40	170	0.81	56	186	0.87	48	178	0.85	92	221	0.85
8	10	110	0.75	28	148	0.86	56	184	0.90	37	160	0.90	42	170	0.85	62	192	0.88	89	218	0.86
9	27	150	0.80	39	170	0.79	33	156	0.87	40	173	0.77	69	196	0.92	54	182	0.90	70	199	0.89
10	18	130	0.82	33	155	0.89	43	171	0.86	65	196	0.86	49	182	0.81	65	194	0.89	51	180	0.87
11	35	157	0.90	23	145	0.75	49	180	0.84	46	181	0.78	42	170	0.85	99	225	0.87	49	180	0.84
12	11	113	0.76	43	173	0.83	30	152	0.85	52	186	0.81	48	176	0.88	52	182	0.86	56	185	0.88
13	31	153	0.87	17	124	0.89	28	139	1.04	28	148	0.86	43	170	0.88	48	179	0.84	60	190	0.87
14	34	157	0.88	13	115	0.85	44	174	0.84	30	152	0.85	44	173	0.85	55	185	0.87	58	190	0.85
15	30	152	0.85	34	159	0.85	22	132	0.96	49	185	0.77	33	160	0.81	54	183	0.88	64	193	0.89
16	23	137	0.89	40	171	0.80	23	134	0.96	34	158	0.86	71	197	0.93	49	180	0.84	69	200	0.86

Continued

Treatment 7																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	75	205	0.87	89	210	0.96	101	231	0.82	125	240	0.90	100	230	0.82	102	220	0.96
2	74	203	0.88	84	205	0.98	93	222	0.85	99	229	0.82	102	232	0.82	118	230	0.97
3	70	200	0.88	79	208	0.88	115	245	0.78	91	221	0.84	110	240	0.80	166	268	0.86
4	68	199	0.86	95	225	0.83	97	227	0.83	116	236	0.88	121	240	0.88	115	240	0.83
5	65	195	0.88	87	217	0.85	100	230	0.82	131	240	0.95	113	230	0.93	107	234	0.84
6	82	211	0.87	96	227	0.82	88	218	0.85	90	220	0.85	115	235	0.89	113	240	0.82
7	79	205	0.92	100	220	0.94	74	207	0.83	112	232	0.90	117	240	0.85	111	238	0.82
8	81	210	0.87	85	215	0.86	82	212	0.86	81	211	0.86	114	236	0.87	131	245	0.89
9	84	210	0.91	90	220	0.85	81	211	0.86	128	242	0.90	112	230	0.92	139	255	0.84
10	70	200	0.88	86	215	0.87	78	208	0.87	86	216	0.85	111	229	0.92	104	220	0.98
11	69	199	0.88	98	225	0.86	87	217	0.85	122	242	0.86	119	230	0.98	105	220	0.99
12	74	203	0.88	85	210	0.92	89	219	0.85	129	240	0.93	108	238	0.80	100	225	0.88
13	78	208	0.87	86	211	0.92	86	216	0.85	142	250	0.91	124	245	0.84	88	220	0.83
14	81	210	0.87	86	214	0.88	79	209	0.87	86	210	0.93	113	233	0.89	160	260	0.91
15	76	210	0.82	89	220	0.84	81	211	0.86	100	218	0.97	134	248	0.88	123	245	0.84
16	72	200	0.90	90	221	0.83	83	213	0.86	116	230	0.95	98	228	0.83	101	230	0.83
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	138	250	0.88	99	235	0.76	130	245	0.88	102	218	0.98	140	265	0.75	128	250	0.82
2	181	275	0.87	115	240	0.83	134	245	0.91	107	235	0.82	136	250	0.87	108	235	0.83
3	145	250	0.93	119	235	0.92	111	235	0.86	179	275	0.86	136	248	0.89	134	255	0.81
4	119	240	0.86	115	245	0.78	97	230	0.80	226	290	0.93	102	235	0.79	147	250	0.94
5	183	274	0.89	108	235	0.83	162	263	0.89	193	288	0.81	141	265	0.76	136	260	0.77
6	98	220	0.92	76	215	0.76	162	265	0.87	108	225	0.95	115	240	0.83	145	260	0.82
7	104	225	0.91	127	240	0.92	219	295	0.85	157	270	0.80	195	285	0.84	201	299	0.75
8	104	223	0.94	96	205	1.11	187	285	0.81	115	235	0.89	186	284	0.81	174	275	0.84
9	112	240	0.81	132	255	0.80	164	270	0.83	106	222	0.97	116	245	0.79	143	255	0.86
10	144	260	0.82	113	240	0.82	134	250	0.86	124	245	0.84	151	260	0.86	154	260	0.88
11	96	220	0.90	172	270	0.87	89	230	0.73	103	225	0.90	140	256	0.83	161	255	0.97
12	146	260	0.83	132	245	0.90	93	220	0.87	149	262	0.83	133	260	0.76	106	230	0.87
13	107	235	0.82	187	275	0.90	63	200	0.79	109	240	0.79	120	235	0.92	101	235	0.78
14	69	200	0.86	150	260	0.85	104	225	0.91	106	237	0.80	110	225	0.97	102	235	0.79
15	56	190	0.82	90	220	0.85	70	200	0.88	135	255	0.81	100	210	1.08	111	235	0.86
16	101	230	0.83	79	200	0.99	86	220	0.81	110	245	0.75	115	236	0.87	120	245	0.82

Continued

Treatment 8																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	2	60	0.93	15	125	0.77	10	100	1.00	24	137	0.93	12	113	0.83	22	136	0.87	42	170	0.85
2	2	60	0.93	8	100	0.80	5	85	0.81	23	134	0.96	14	116	0.90	36	155	0.97	29	152	0.83
3	3	70	0.87	12	115	0.79	4	74	0.99	24	145	0.79	18	129	0.84	18	130	0.82	23	137	0.89
4	2	60	0.93	3	70	0.87	6	90	0.82	18	128	0.86	22	137	0.86	32	153	0.89	39	168	0.82
5	2	60	0.93	8	100	0.80	8	97	0.88	16	127	0.78	11	117	0.69	21	134	0.87	31	155	0.83
6	1	50	0.80	5	85	0.81	12	109	0.93	13	117	0.81	19	132	0.83	21	135	0.85	24	141	0.86
7	1	48	0.90	4	80	0.78	10	102	0.94	13	115	0.85	18	130	0.82	7	103	0.64	31	155	0.83
8	2	59	0.97	5	85	0.81	2	60	0.93	7	96	0.79	19	134	0.79	26	145	0.85	21	140	0.77
9	2	62	0.84	14	121	0.79	5	85	0.81	6	92	0.77	18	131	0.80	10	110	0.75	16	122	0.88
10	2	63	0.80	4	79	0.81	4	75	0.95	5	90	0.69	23	137	0.89	12	112	0.85	30	147	0.94
11	1	54	0.64	2	65	0.73	6	86	0.94	6	91	0.80	11	110	0.83	16	126	0.80	22	138	0.84
12	2	64	0.76	2	65	0.73	8	93	0.99	3	78	0.63	20	134	0.83	14	118	0.85	32	156	0.84
13	2	63	0.80	2	63	0.80	6	87	0.91	4	81	0.75	18	129	0.84	11	110	0.83	27	146	0.87
14	2	64	0.76	2	65	0.73	8	95	0.93	2	66	0.70	18	127	0.88	14	118	0.85	36	161	0.86
15	2	58	1.03	1	50	0.80	9	95	1.05	2	66	0.70	18	128	0.86	16	127	0.78	29	153	0.81
16	1	52	0.71	6	90	0.82	6	85	0.98	2	70	0.58	20	132	0.87	31	154	0.85	55	191	0.79
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	58	191	0.83	37	168	0.78	58	188	0.87	52	181	0.88	64	193	0.89	65	198	0.84	66	195	0.89
2	20	133	0.85	33	161	0.79	37	160	0.90	56	190	0.82	39	171	0.78	74	204	0.87	57	186	0.89
3	42	170	0.85	41	170	0.83	55	183	0.90	42	175	0.78	91	216	0.90	62	193	0.86	71	200	0.89
4	8	103	0.73	31	155	0.83	48	176	0.88	54	192	0.76	66	197	0.86	68	197	0.89	69	198	0.89
5	35	158	0.89	40	170	0.81	46	175	0.86	27	147	0.85	55	187	0.84	55	187	0.84	65	194	0.89
6	36	158	0.91	25	150	0.74	26	140	0.95	56	192	0.79	43	174	0.82	46	177	0.83	68	197	0.89
7	37	160	0.90	36	166	0.79	27	144	0.90	61	195	0.82	69	198	0.89	82	212	0.86	64	194	0.88
8	43	172	0.85	35	165	0.78	41	170	0.83	71	200	0.89	76	209	0.83	65	200	0.81	70	200	0.88
9	42	170	0.85	47	170	0.96	42	171	0.84	49	178	0.87	43	175	0.80	75	175	1.40	58	188	0.87
10	23	137	0.89	32	158	0.81	65	205	0.75	55	185	0.87	54	182	0.90	75	175	1.40	66	194	0.90
11	32	153	0.89	46	178	0.82	34	155	0.91	47	177	0.85	50	180	0.86	64	197	0.84	74	203	0.88
12	23	137	0.89	33	159	0.82	54	186	0.84	36	166	0.79	77	210	0.83	57	189	0.84	63	193	0.88
13	46	173	0.89	32	157	0.83	65	195	0.88	29	151	0.84	53	184	0.85	63	195	0.85	67	196	0.89
14	31	151	0.90	26	152	0.74	32	155	0.86	54	184	0.87	66	195	0.89	84	210	0.91	65	196	0.86
15	49	185	0.77	27	154	0.74	37	168	0.78	52	184	0.83	43	175	0.80	58	190	0.85	69	200	0.86
16	29	148	0.89	25	142	0.87	32	158	0.81	47	177	0.85	40	170	0.81	73	205	0.85	76	206	0.87

Continued

Treatment 8																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	72	201	0.89	76	206	0.87	100	230	0.82	90	220	0.85	94	223	0.85	354	330	0.99
2	62	191	0.89	70	200	0.88	86	215	0.87	96	225	0.84	102	234	0.80	277	300	1.03
3	59	189	0.87	89	219	0.85	78	205	0.91	94	225	0.83	104	232	0.83	80	205	0.93
4	71	200	0.89	69	199	0.88	75	205	0.87	99	225	0.87	130	250	0.83	108	230	0.89
5	72	201	0.89	74	204	0.87	92	222	0.84	94	225	0.83	102	232	0.82	86	215	0.87
6	84	213	0.87	92	223	0.83	93	223	0.84	97	225	0.85	80	209	0.88	83	220	0.78
7	81	210	0.87	84	214	0.86	88	215	0.89	89	217	0.87	80	210	0.86	83	215	0.84
8	90	220	0.85	79	210	0.85	74	202	0.90	105	230	0.86	100	230	0.82	86	220	0.81
9	71	200	0.89	74	215	0.74	95	225	0.83	93	223	0.84	86	210	0.93	142	260	0.81
10	70	199	0.89	64	195	0.86	71	200	0.89	94	224	0.84	183	285	0.79	101	220	0.95
11	62	190	0.90	75	205	0.87	96	226	0.83	97	227	0.83	121	241	0.86	229	300	0.85
12	74	202	0.90	75	205	0.87	87	215	0.88	96	226	0.83	80	210	0.86	86	210	0.93
13	72	201	0.89	76	204	0.90	86	215	0.87	87	215	0.88	75	205	0.87	121	240	0.88
14	69	198	0.89	78	207	0.88	91	219	0.87	100	219	0.95	125	245	0.85	83	205	0.96
15	70	199	0.89	69	199	0.88	78	205	0.91	90	221	0.83	120	240	0.87	78	220	0.73
16	77	206	0.88	74	204	0.87	90	220	0.85	95	226	0.82	80	209	0.88	107	235	0.82
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	206	304	0.73	192	285	0.83	80	210	0.86	190	280	0.87	175	270	0.89	199	275	0.96
2	187	280	0.85	109	235	0.84	138	257	0.81	108	236	0.82	177	275	0.85	221	300	0.82
3	131	263	0.72	115	239	0.84	221	300	0.82	88	217	0.86	229	280	1.04	134	240	0.97
4	102	234	0.80	92	225	0.81	80	210	0.86	237	311	0.79	214	295	0.83	210	290	0.86
5	126	245	0.86	160	270	0.81	109	240	0.79	213	296	0.82	175	275	0.84	229	309	0.78
6	135	250	0.86	203	285	0.88	209	295	0.81	86	220	0.81	190	280	0.87	207	302	0.75
7	79	210	0.85	224	290	0.92	288	320	0.88	138	245	0.94	164	270	0.83	158	260	0.90
8	115	235	0.89	227	305	0.80	80	210	0.86	113	240	0.82	146	260	0.83	185	286	0.79
9	153	267	0.80	73	213	0.76	135	260	0.77	180	286	0.77	153	265	0.82	191	283	0.84
10	194	293	0.77	98	220	0.92	103	235	0.79	106	234	0.83	123	250	0.79	168	275	0.81
11	113	242	0.80	96	225	0.84	122	250	0.78	124	256	0.74	124	248	0.81	192	290	0.79
12	115	245	0.78	163	270	0.83	261	316	0.83	213	294	0.84	115	247	0.76	122	245	0.83
13	227	319	0.70	179	280	0.82	88	220	0.83	221	310	0.74	115	240	0.83	121	205	1.40
14	137	160	3.34	145	260	0.82	96	235	0.74	156	240	1.13	105	235	0.81	94	230	0.77
15	163	266	0.87	152	260	0.86	135	255	0.81	112	238	0.83	127	240	0.92	105	225	0.92
16	78	211	0.83	70	205	0.81	186	283	0.82	120	240	0.87	120	234	0.94	110	240	0.80

Continued

Treatment 9																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	2	60	0.93	4	80	0.78	11	105	0.95	5	85	0.81	14	120	0.81	21	133	0.89	33	157	0.85
2	2	64	0.76	4	76	0.91	5	85	0.81	4	87	0.61	16	121	0.90	22	135	0.89	31	153	0.87
3	2	62	0.84	8	99	0.82	5	80	0.98	27	150	0.80	22	141	0.78	14	118	0.85	33	156	0.87
4	2	63	0.80	10	105	0.86	13	113	0.90	17	125	0.87	17	122	0.94	47	184	0.75	45	177	0.81
5	2	61	0.88	5	87	0.76	5	86	0.79	21	140	0.77	12	107	0.98	17	126	0.85	38	166	0.83
6	2	57	1.08	6	91	0.80	11	110	0.83	2	72	0.54	14	115	0.92	23	137	0.89	17	126	0.85
7	2	59	0.97	6	90	0.82	2	62	0.84	20	137	0.78	24	142	0.84	6	93	0.75	11	115	0.72
8	3	73	0.77	5	88	0.73	9	102	0.85	9	105	0.78	16	124	0.84	15	120	0.87	18	132	0.78
9	1	50	0.80	4	80	0.78	9	103	0.82	19	132	0.83	20	130	0.91	38	164	0.86	15	123	0.81
10	1	50	0.80	3	74	0.74	3	70	0.87	4	84	0.67	14	117	0.87	12	114	0.81	20	135	0.81
11	1	50	0.80	1	45	1.10	2	59	0.97	3	79	0.61	24	135	0.98	16	121	0.90	23	137	0.89
12	4	47	3.85	1	52	0.71	4	72	1.07	12	116	0.77	27	148	0.83	20	130	0.91	11	116	0.70
13	1	49	0.85	2	62	0.84	5	80	0.98	2	68	0.64	14	120	0.81	18	128	0.86	28	147	0.88
14	1	54	0.64	4	80	0.78	13	113	0.90	6	93	0.75	16	125	0.82	19	130	0.86	25	146	0.80
15	1	48	0.90	5	90	0.69	2	67	0.66	5	93	0.62	20	131	0.89	15	120	0.87	24	142	0.84
16	2	60	0.93	8	100	0.80	18	130	0.82	5	92	0.64	23	135	0.93	26	144	0.87	22	138	0.84
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	17	121	0.96	36	162	0.85	47	175	0.88	35	160	0.85	62	195	0.84	63	190	0.92	51	182	0.85
2	30	152	0.85	63	198	0.81	33	158	0.84	52	184	0.83	36	166	0.79	60	190	0.87	54	185	0.85
3	51	181	0.86	59	193	0.82	27	145	0.89	47	177	0.85	42	176	0.77	62	190	0.90	74	202	0.90
4	34	157	0.88	35	160	0.85	40	170	0.81	46	178	0.82	52	182	0.86	58	190	0.85	60	192	0.85
5	22	135	0.89	61	192	0.86	56	182	0.93	45	174	0.85	45	175	0.84	75	205	0.87	72	200	0.90
6	60	190	0.87	34	158	0.86	24	137	0.93	36	168	0.76	54	192	0.76	59	189	0.87	62	193	0.86
7	32	160	0.78	34	158	0.86	28	140	1.02	48	180	0.82	43	172	0.85	66	195	0.89	84	213	0.87
8	32	159	0.80	28	155	0.75	43	174	0.82	47	176	0.86	40	170	0.81	71	200	0.89	62	193	0.86
9	28	148	0.86	38	166	0.83	34	160	0.83	20	135	0.81	66	200	0.83	59	189	0.87	44	175	0.82
10	39	169	0.81	28	155	0.75	54	180	0.93	62	190	0.90	56	188	0.84	63	190	0.92	62	192	0.88
11	27	150	0.80	22	135	0.89	26	140	0.95	60	190	0.87	59	190	0.86	61	190	0.89	57	188	0.86
12	17	121	0.96	24	140	0.87	40	170	0.81	48	179	0.84	39	165	0.87	65	195	0.88	65	196	0.86
13	32	160	0.78	20	130	0.91	60	190	0.87	38	168	0.80	50	180	0.86	56	185	0.88	82	212	0.86
14	26	148	0.80	41	171	0.82	42	173	0.81	22	138	0.84	59	192	0.83	70	200	0.88	87	216	0.86
15	41	173	0.79	39	169	0.81	40	169	0.83	20	135	0.81	44	175	0.82	69	199	0.88	69	200	0.86
16	16	122	0.88	35	156	0.92	22	135	0.89	21	134	0.87	55	185	0.87	60	189	0.89	61	192	0.86

Continued

Treatment 9																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	79	206	0.90	77	207	0.87	92	222	0.84	78	205	0.91	105	230	0.86	98	225	0.86
2	70	199	0.89	80	210	0.86	78	208	0.87	108	235	0.83	84	217	0.82	86	220	0.81
3	73	202	0.89	84	213	0.87	80	210	0.86	91	221	0.84	94	212	0.99	83	220	0.78
4	75	204	0.88	89	219	0.85	78	208	0.87	75	200	0.94	83	210	0.90	138	250	0.88
5	81	209	0.89	86	215	0.87	83	214	0.85	86	215	0.87	80	215	0.80	128	240	0.93
6	69	198	0.89	76	204	0.90	84	210	0.91	92	218	0.89	130	248	0.85	94	215	0.95
7	78	207	0.88	82	210	0.89	74	204	0.87	79	208	0.88	87	220	0.82	93	220	0.87
8	76	205	0.88	69	199	0.88	81	211	0.86	85	210	0.92	68	190	0.99	70	200	0.88
9	79	209	0.87	64	195	0.86	78	207	0.88	88	215	0.89	81	215	0.82	138	255	0.83
10	69	198	0.89	59	190	0.86	82	212	0.86	90	218	0.87	96	220	0.90	77	208	0.86
11	72	200	0.90	72	199	0.91	87	217	0.85	86	216	0.85	76	200	0.95	178	270	0.90
12	74	204	0.87	99	225	0.87	88	218	0.85	92	222	0.84	99	220	0.93	71	203	0.85
13	72	205	0.84	92	222	0.84	82	212	0.86	90	220	0.85	98	230	0.81	65	195	0.88
14	73	205	0.85	89	219	0.85	81	210	0.87	70	199	0.89	135	255	0.81	57	188	0.86
15	71	200	0.89	62	190	0.90	81	210	0.87	98	227	0.84	83	215	0.84	89	222	0.81
16	60	189	0.89	61	190	0.89	72	202	0.87	75	203	0.90	70	195	0.94	60	191	0.86
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	114	240	0.82	116	235	0.89	118	240	0.85	105	210	1.13	80	216	0.79	129	250	0.83
2	133	246	0.89	82	210	0.89	90	225	0.79	106	240	0.77	160	280	0.73	175	280	0.80
3	80	208	0.89	96	220	0.90	106	235	0.82	116	233	0.92	115	245	0.78	125	256	0.75
4	116	243	0.81	95	225	0.83	183	280	0.83	128	250	0.82	123	240	0.89	148	270	0.75
5	104	234	0.81	95	220	0.89	122	236	0.93	108	230	0.89	96	235	0.74	120	245	0.82
6	135	255	0.81	192	281	0.87	88	221	0.82	105	220	0.99	135	255	0.81	140	265	0.75
7	137	256	0.82	95	226	0.82	90	224	0.80	140	246	0.94	98	235	0.76	112	240	0.81
8	75	200	0.94	97	227	0.83	137	255	0.83	121	240	0.88	140	260	0.80	125	250	0.80
9	83	210	0.90	85	218	0.82	90	225	0.79	100	212	1.05	113	235	0.87	106	235	0.82
10	113	240	0.82	90	220	0.85	138	255	0.83	120	225	1.05	153	265	0.82	122	250	0.78
11	66	195	0.89	114	240	0.82	63	200	0.79	157	262	0.87	133	258	0.77	126	257	0.74
12	74	203	0.88	125	246	0.84	81	210	0.87	110	235	0.85	110	238	0.82	114	245	0.78
13	79	209	0.87	122	240	0.88	81	210	0.87	113	232	0.90	175	272	0.87	111	240	0.80
14	109	237	0.82	78	211	0.83	135	255	0.81	103	225	0.90	87	220	0.82	134	250	0.86
15	125	250	0.80	131	250	0.84	110	233	0.87	102	235	0.79	135	253	0.83	93	230	0.76
16	106	236	0.81	102	230	0.84	96	205	1.11	125	230	1.03	94	230	0.77	110	235	0.85

Continued

Treatment 10																					
Day	**0**			**7**			**14**			**21**			**28**			**35**			**42**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	2	62	0.84	4	83	0.70	11	105	0.95	4	78	0.84	15	119	0.89	46	182	0.76	19	130	0.86
2	2	61	0.88	8	100	0.80	8	98	0.85	7	95	0.82	21	134	0.87	26	144	0.87	24	142	0.84
3	3	73	0.77	10	106	0.84	8	94	0.96	11	109	0.85	15	117	0.94	33	156	0.87	39	166	0.85
4	2	59	0.97	5	86	0.79	6	90	0.82	19	130	0.86	18	128	0.86	21	131	0.93	23	140	0.84
5	2	60	0.93	4	76	0.91	9	100	0.90	5	80	0.98	11	106	0.92	30	152	0.85	23	142	0.80
6	2	58	1.03	4	78	0.84	10	105	0.86	16	121	0.90	15	120	0.87	26	144	0.87	20	132	0.87
7	4	84	0.67	9	100	0.90	6	90	0.82	15	122	0.83	16	124	0.84	11	111	0.80	34	159	0.85
8	2	60	0.93	6	90	0.82	1	47	0.96	3	70	0.87	10	105	0.86	26	142	0.91	12	114	0.81
9	2	59	0.97	2	57	1.08	9	100	0.90	4	74	0.99	27	146	0.87	26	143	0.89	17	130	0.77
10	2	60	0.93	1	47	0.96	10	107	0.82	2	60	0.93	18	130	0.82	16	124	0.84	16	122	0.88
11	1	50	0.80	3	70	0.87	6	85	0.98	6	90	0.82	14	119	0.83	14	118	0.85	16	123	0.86
12	1	52	0.71	4	80	0.78	13	116	0.83	2	62	0.84	26	145	0.85	19	135	0.77	26	147	0.82
13	1	51	0.75	2	60	0.93	13	115	0.85	14	119	0.83	25	142	0.87	13	120	0.75	25	146	0.80
14	2	60	0.93	1	50	0.80	6	86	0.94	9	101	0.87	24	140	0.87	10	115	0.66	55	185	0.87
15	2	60	0.93	2	60	0.93	7	91	0.93	13	115	0.85	21	135	0.85	12	116	0.77	25	146	0.80
16	3	71	0.84	2	60	0.93	7	89	0.99	8	97	0.88	17	125	0.87	42	170	0.85	35	165	0.78
Day	**49**			**56**			**63**			**70**			**77**			**84**			**91**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	35	158	0.89	38	166	0.83	69	206	0.79	40	168	0.84	37	167	0.79	94	220	0.88	72	200	0.90
2	28	150	0.83	64	191	0.92	63	198	0.81	47	176	0.86	41	172	0.81	99	230	0.81	69	198	0.89
3	22	135	0.89	37	166	0.81	52	184	0.83	71	201	0.87	94	220	0.88	56	186	0.87	58	187	0.89
4	39	169	0.81	45	178	0.80	35	160	0.85	38	165	0.85	40	170	0.81	57	188	0.86	84	211	0.89
5	32	158	0.81	24	142	0.84	65	200	0.81	59	186	0.92	53	184	0.85	46	179	0.80	74	203	0.88
6	13	124	0.68	28	148	0.86	31	156	0.82	72	205	0.84	54	185	0.85	53	185	0.84	76	206	0.87
7	46	175	0.86	29	150	0.86	48	177	0.87	57	187	0.87	49	179	0.85	106	235	0.82	94	225	0.83
8	22	135	0.89	23	140	0.84	33	158	0.84	47	180	0.81	56	189	0.83	61	192	0.86	80	209	0.88
9	46	174	0.87	23	138	0.88	40	168	0.84	72	208	0.80	49	180	0.84	65	196	0.86	49	170	1.00
10	30	151	0.87	42	174	0.80	47	175	0.88	40	169	0.83	62	193	0.86	70	200	0.88	62	190	0.90
11	34	156	0.90	32	156	0.84	48	179	0.84	39	168	0.82	57	188	0.86	50	181	0.84	64	192	0.90
12	42	164	0.95	35	160	0.85	22	138	0.84	87	215	0.88	54	184	0.87	106	237	0.80	78	205	0.91
13	26	144	0.87	21	134	0.87	36	165	0.80	44	174	0.84	43	174	0.82	56	187	0.86	76	205	0.88
14	18	134	0.75	42	175	0.78	72	218	0.69	45	176	0.83	46	177	0.83	63	194	0.86	71	200	0.89
15	12	114	0.81	38	169	0.79	48	176	0.88	37	165	0.82	61	191	0.88	77	208	0.86	82	210	0.89
16	60	192	0.85	40	169	0.83	27	145	0.89	52	182	0.86	47	177	0.85	44	175	0.82	73	202	0.89

Continued

Treatment 10																		
Day	**98**			**105**			**112**			**119**			**126**			**133**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	76	206	0.87	88	215	0.89	75	205	0.87	65	193	0.90	84	214	0.86	142	240	1.03
2	88	215	0.89	91	219	0.87	89	215	0.90	87	215	0.88	88	215	0.89	118	245	0.80
3	82	212	0.86	82	212	0.86	86	216	0.85	96	226	0.83	91	220	0.85	154	260	0.88
4	80	210	0.86	79	208	0.88	94	224	0.84	91	219	0.87	87	217	0.85	149	260	0.85
5	75	205	0.87	78	208	0.87	68	195	0.92	84	210	0.91	96	226	0.83	114	225	1.00
6	69	198	0.89	74	203	0.88	81	209	0.89	111	239	0.81	98	228	0.83	110	230	0.90
7	84	210	0.91	84	213	0.87	76	205	0.88	79	206	0.90	100	229	0.83	137	255	0.83
8	76	205	0.88	72	202	0.87	78	205	0.91	90	219	0.86	83	214	0.85	112	225	0.98
9	72	200	0.90	82	210	0.89	86	210	0.93	97	225	0.85	92	220	0.86	61	190	0.89
10	78	210	0.84	70	200	0.88	79	207	0.89	88	216	0.87	90	219	0.86	85	215	0.86
11	68	197	0.89	69	197	0.90	105	234	0.82	87	216	0.86	94	224	0.84	99	235	0.76
12	82	210	0.89	74	200	0.93	108	237	0.81	108	235	0.83	91	221	0.84	122	230	1.00
13	75	205	0.87	78	204	0.92	90	220	0.85	77	207	0.87	90	220	0.85	97	223	0.87
14	80	210	0.86	70	199	0.89	89	219	0.85	113	240	0.82	91	220	0.85	114	234	0.89
15	74	205	0.86	80	210	0.86	93	223	0.84	86	215	0.87	93	220	0.87	82	214	0.84
16	71	200	0.89	81	210	0.87	82	213	0.85	100	229	0.83	95	225	0.83	97	223	0.87
Day	**140**			**147**			**154**			**161**			**168**			**175**		
Sample	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**	**M(g)**	**L(mm)**	**CF**
1	117	230	0.96	73	205	0.85	150	260	0.85	191	280	0.87	267	300	0.99	281	320	0.86
2	98	230	0.81	117	245	0.80	140	245	0.95	166	270	0.84	145	250	0.93	141	256	0.84
3	96	225	0.84	139	250	0.89	130	237	0.98	87	220	0.82	264	310	0.89	181	283	0.80
4	230	290	0.94	84	215	0.85	136	240	0.98	139	250	0.89	158	275	0.76	135	240	0.98
5	95	215	0.96	120	250	0.77	156	255	0.94	74	210	0.80	198	285	0.86	115	230	0.95
6	93	225	0.82	177	284	0.77	110	230	0.90	269	315	0.86	181	280	0.82	266	310	0.89
7	115	240	0.83	93	236	0.71	130	241	0.93	119	240	0.86	137	250	0.88	325	335	0.86
8	188	283	0.83	237	304	0.84	162	270	0.82	123	245	0.84	117	236	0.89	202	299	0.76
9	128	250	0.82	208	296	0.80	227	300	0.84	109	230	0.90	183	281	0.82	200	298	0.76
10	107	235	0.82	211	292	0.85	144	252	0.90	206	290	0.84	133	255	0.80	145	270	0.74
11	245	314	0.79	267	315	0.85	235	314	0.76	103	230	0.85	166	267	0.87	214	290	0.88
12	176	270	0.89	227	292	0.91	134	260	0.76	273	315	0.87	201	293	0.80	222	300	0.82
13	178	280	0.81	105	228	0.89	147	256	0.88	159	260	0.90	222	300	0.82	278	330	0.77
14	102	225	0.90	95	224	0.85	104	243	0.72	153	260	0.87	157	270	0.80	175	280	0.80
15	223	286	0.95	78	209	0.85	132	257	0.78	220	295	0.86	162	260	0.92	117	238	0.87
16	106	230	0.87	94	230	0.77	120	236	0.91	198	285	0.86	301	320	0.92	112	250	0.72