Top Ten Things You Must Know When Moving From Small To Large Scale Production

Eunkyeong (Esther) Lee
Food Scientist

Tel: 902-368-5238
Email: elee@biofoodtech.ca

Originally published by PEI Business Development, March 2004

BIO | FOOD | TECH
CONCEPT TO PILOT TO MARKET

TABLE OF CONTENTS

INTRODUCTION

For a small scale food producer, taking the next step towards large scale production could be challenging and overwhelming. Owners of many such companies have fears, and may not know where to begin or how to expand their business to the next level. Regardless of the types of food products, these entrepreneurs share common concerns.

This paper identifies common concerns faced by owners of small food companies and discusses ways to deal with them in an organised manner. It is intended to help small business owners in the expansion of their food processing and production business. It also addresses key issues that they should consider when moving from small scale to large scale production.

KNOW YOUR PRODUCT

You may already have been producing in small scale, and you know your product well. But when you move from small scale to large scale production, the overall expectations of your product getting into the larger market would change. Therefore, you have to specify your product. To develop a product specification, you must know what the product is, who the consumers are, and what the consumers want.

***What* the product is:**

Your product may have a homemade kind of image because it is produced in small scale in your home kitchen. When you produce in large scale, the quality characteristics of the product may alter. Changes in sensory characteristics such as flavour and texture are commonly observed as production is moved from small scale to large scale.

The quality characteristics of your product play a vital role in its market. They include appearance, flavour, texture, nutritional qualities, serving size, and package material, colour, and graphics. Flavour, texture, and appearance are the product characteristics that determine sensory quality of your product. Serving sizes become important when nutritional labels are used on the products, as weight and percent composition of nutritional elements would have to be listed in the labels. Another important aspect is product packaging. The material used for packaging can affect the shelf-life of the product content whereas the colour and graphics on the package are critical to attracting consumers' attention.

Some of the product attributes determine the expected final product quality. Ranking of product attributes can guide you towards better positioning of the product in its market. Some attributes may have more weight than the others. In the case of a coffee product, the aroma and taste characteristics may be more important than the texture. The key attributes of your product may weigh heavily on the consumer's choice against your competitor's product.

***Who* the consumers are:**

Your consumers may have been residents of your friendly neighbourhood or nearby villages who buy your product in small stores or farmer's markets. But when you move to large scale production, your consumers may be located across the country or even in another country. As your production scale changes, you need to be aware of the characteristics of consumers that are likely to appreciate your product. You should specify the age group, income level, and role of target consumers who are likely to purchase your product. These specifications will later affect your decisions on product pricing and where you will sell your product.

***What* the consumers want:**

Your current consumers may be content with the products available in the local market. When you are in the national or global market, the typical consumer is exposed to wider variety of products in the market, and their expectations are different; they will compare your product against others. You will have to identify the consumers' acceptance and preference levels to increase the chances of your product's success.

DETERMINE WHERE YOUR PRODUCT STANDS

Once you are armed with the knowledge of potential consumers, you must prepare yourself to address some critical marketing issues. You need to determine the positioning of your product, time your product's market introduction, and gather information on your product's potential competitors.

Product's position:

Product's position is critical. You must determine where your product is going to be placed. For instance, if it is placed on the supermarket shelf, is it shelf-stable, frozen or refrigerated? Where on the grocery shelf would your product be kept? Do the colours and graphics of your product package stand out to a customer? Would she find your product the most convenient one on the shelf? Does it offer the best value for price in her eyes? Does it have a specific statement which will easily differentiate it from its competing products? These questions pertain to 'market position' or an 'advantage' that your product has over competitor's products.

Product's position can be changed by different means. A classic example is how a company changed the position of its tofu product in the 1980's through the introduction of a breakthrough technology. Tofu products have been in the refrigerated section of supermarkets for so many years just like dairy products as they were low-acid products which fall under microbiological high-risk product category. One Californian company introduced a shelf-stable tofu product that was produced using aseptic technology, highlighting the quality and microbiological safety advantages. By doing so, they changed the location of the tofu product from the refrigerated section to the shelf-stable product section.

Timing of product's market introduction:

The market introduction of the product must be well timed. An example of well-timed product introduction is that of the imitation crab product in the US. This product was introduced in the 1970's when crab was in great short supply. The imitation crab contains *surimi* which is minced processed fish commonly used in Asian countries. Ever since, the imitation crab and other imitation shellfish products are widely used in western countries as less expensive and flavourful substitutes for seafood and meat in a variety of food preparations.

Potential Competitors:

You should not overlook the potential competition. Your potential competitors may use marketing strategies such as price cuts, extensive advertising, couponing, two-for-one sales, and even pressure on the retailers. You must ask yourself: are your marketing strategies and product attributes strong enough to withstand the competition?

PRICE YOUR PRODUCT RIGHT

Pricing of your product could be determined based on the financial evaluation of projected production cost, return on invested capital, profit margins, and other economic and accounting parameters. Most of the product cost is estimated from the following expenses:

- ingredients;
- packaging;
- plant labour;
- manufacturing;
- distribution;
- equipment;
- capital depreciation;
- advertising and promotion;
- supermarket slotting allowances;
- R & D support;
- organisational overhead, such as accounting, consumer services, and other managerial functions.

The product cost is only one of the factors that determine your product's price. Your product may have other important attributes. Therefore, you should consider all the attributes of your product and weigh them against those of your competitor's product. The price cannot be separated from the concept of *value* delivered by the product. One way to view product value is the overall impact of the product on a consumer's quality of life. For middle to upper income consumers, value perceptions may be based on quality perceptions (e.g. organic food products) or convenience (e.g. microwavable dinners). Often times, value may be based on serving sizes, nutritional profiles, and types of packaging. For some consumers, large product sizes may be perceived as wasteful, whereas others may prefer products with low prices or large quantities.

Your product's value must be established in relation to its competition. Two extreme market positions would be "high-price low-volume" and "low-price high-volume." Price should reflect your product's perceived value and competitive advantage.

STANDARDISE YOUR PRODUCT FORMULATION

Your small scale product may have been produced using a recipe. When you are producing in large volume, it will be impractical and inefficient to use small measuring recipe units. Furthermore, it will result in large variations in the quality of your finished product. Therefore, you must standardize the product formulation.

The initial formulation is usually carried out during the feasibility phases of scale-up production. The product formulation is derived from the measurements of ingredients used in the basic recipe, and it involves standardisation of ingredient composition. If your basic recipe measurements use cups of flour and pieces of medium size potatoes, they will have to be converted into measurement units such as grams and kilograms. In other words, the recipe is translated into a formula containing reproducible standard units. Each ingredient must be expressed in terms of weight, even when present in low quantities, such as a pinch of salt. Your small scale procedure may be "simmer at low heat until tender." In this case, the temperature and length of cooking time will have to be defined, as in "cook at 55 degrees Celsius for 15 minutes." It will also be useful to keep your formulation by standardising in percent composition, if your production volume varies from day to day or from batch to batch.

An important aspect of a product is its ingredient composition. Product ingredients will have to be selected to meet various criteria such as quality, variability, cost, processibility, shelf-life, safety and availability.

Quality: The quality of product ingredient that is most appropriate to the product should be specified. As part of process control records, ***Ingredient specifications*** are required to comply with good manufacturing practices and quality standards.

Variability: The variability of ingredient could affect the product characteristics such as colour, flavour, or moisture content. A set of ***performance specifications*** should be in place for large scale production.

Cost: Product ingredients with similar attributes could vary in cost. You must find the least expensive substitute that meets all the quality, performance, as well as shelf-life criteria specified in the initial recipe.

Consolidation of ingredients by reducing total number of ingredients and suppliers could result in large cost savings due to increased manufacturing efficiency, improved supplier support, and better inventory control as well as decreased paperwork and coordination cost.

Processibility: Ingredients that you use in the production must tolerate the process. In other words, small variations in ingredient quality should not affect the overall performance of the ingredient. For example, water temperature could affect the fermentation process of the dough, resulting in different texture and degree of leavening in a given time of proofing. In such case, you should be able to standardise the formula to have consistent texture, by maintaining the water temperature within a tolerable range.

Shelf-life: The ingredients must have enough storage stability to allow adequate warehousing and distribution. Another thing to consider is storage time at consumer's end as the consumer may store the food product further before it is prepared and consumed. In this regard, the producer needs to ensure that the product ingredients have stable shelf-life in order to reduce the incidence of spoilage during the storage time at the consumer's end.

Safety: Each ingredient must meet strict specifications concerning its chemical, physical, and microbiological safety. Furthermore, safe handling practices must be assured for each ingredient.

Availability: Large quantities of ingredients must be in continuous supply. This may require some ingredient substitution in the initial recipe. For

example, an exotic spice might not always be available in fresh form because of its seasonality, whereas a spice extract may be available in guaranteed quantities throughout the year.

BE READY TO MODIFY PROCESSING METHODS

There are several factors that affect the final product quality during the scale-up production. When you compare the production of 100 litres of frozen sauce with one pot of sauce made in the kitchen for immediate consumption, the following scenario can happen:

- The cooking time to soften vegetables may vary;
- The final product yield may vary which will affect flavour, texture, and moisture content of the sauce;
- Freezing step may break down the texture of the solid particles;
- The sauce may separate when frozen and thawed.

In your small scale production, you must have been producing on kitchen equipment in small batches, with a focus on achieving desirable qualities. In the scale-up production, your product may undergo physical, chemical, and biological reactions whose outcomes are difficult to predict. Often times, scale-up studies must be performed by trial and error with larger scale equipment. The efficient way to proceed is step by step or stage by stage, rather than by attempting to integrate all the possible operations at once. In most cases, adjustments have to be made in the scale-up processing.

Some ingredients may be commercially available in ready-to-use forms or they may require extensive preparation, such as vegetable peeling, meat dicing, and defrosting of frozen ingredients. These preparation steps would require much more time when you have to deal with ingredients in large quantities.

Typically, in the kitchen or laboratory, mixing of ingredients may be done by hand in a small bowl or with a kitchen appliance. In a large scale manufacturing facility, mixing is performed on a larger scale and will use mechanisms with operating procedures that are different from the small scale ones. Mixing times then should be determined by experimentation.

When production involves heating and cooling steps, scale-up processing becomes more complex and could take much longer time. Degradation of the mixture components or loss of certain product characteristics may occur due to the extended heating and cooling to achieve the desired temperature of the mixture.

Process modification often requires the use of ingredients that are not listed in the original recipe. Some ingredients are used to reduce the processing time, thus decreasing energy requirements and increasing efficiency. Others are used to enhance easy handling of products. These ingredients, called *processing aids*, are used at very low levels and often include chemical agents. For example, potassium sorbate and cysteine are used to reduce the mixing time in the dough preparation, whereas the addition of calcium chloride controls proofing rate of the dough. In the case of some refrigerated canned dough products, oil mists are sprayed to help prevent products from sticking.

PACKAGE IT RIGHT

Packaging is no longer just a box or a bag that gets a product into a store and then home onto a consumer's shelf. However, no matter how advanced a packaging technology has become, its main goal is to protect the product. The package is an essential part of the food product.

There are two types of packaging for processed foods: *primary packaging* and *secondary packaging*. The primary packaging step may be putting the product in a can, jar, bottle, flexible pouch, bag, or some type of wrapping. It is usually hermetically sealed, which means it eliminates chances of gas, air and moisture getting into the product. A hermetic seal also provides evidence of tampering, which is an increasing safety concern.

After the primary packaging, many food products are processed further to extend shelf-life or to modify their properties. For example, canned products are retorted by heating, ice cream is hardened by cooling, frozen foods are frozen, and some foods are allowed to stand to further develop flavour and texture. The application of post-processing step from a typical small scale batch operation to large scale is a major processing challenge.

Secondary packaging may involve packing containers in shipping cases or trays. It also includes labelling, coding, case coding, and cartoning prior to case packing. Although secondary packaging is not considered in detail in small scale production, it has to be considered at some point of time prior to large scale production, to satisfy shipping requirements.

When using a new shipping case, specifications that describe the results of physical tests such as vibration or drop test must be reviewed. This is to ensure that there will be no breakage or leakage problems during normal shipping and handling. You must also decide on configuration, size, and methodology of utilising large quantities of cases for efficient storage and handling.

DETERMINE PRODUCT SHELF-LIFE

Shelf-life is defined as the maximum amount of time a product retains customer quality expectations. In most cases, before safety becomes an issue, the quality of the product has become unacceptable. The shelf-life of a food product is vital to its success in the marketplace, and is an extremely important attribute for any product.

Types of testing that can be used for shelf-life determination are microbiological, chemical, physical and sensory tests. The most crucial issue is the question of microbiological stability of your product. It is essential to identify and eliminate all possible safety hazards that might arise from the growth of hazardous organisms during production, distribution and storage. You must ensure that pathogenic bacteria such as *Salmonella*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Clostridium perfringens*, *Clostridium botulinum* are eliminated. Presence of other microorganisms such as yeasts, molds, non-pathogenic bacteria that could cause spoilage also has to be addressed.

There are several ways to increase shelf-life of your product. Lowering water activity and pH, modification of headspace gas composition, thermal treatment, and use of additives in the formula are common ways to overcome some of the microbial problems.

Typically, a common approach used to evaluate the product shelf-life is based on the sensory assessment of a quality factor. The use of an expert panel that represents average consumer palate is normally preferred.

In some products, chemical or physical tests that can determine an index of deterioration can be used in the shelf-life study. Examples include moisture, water activity, peroxide value, headspace oxygen content, redox potential, trimethylamine, water-holding capacity, loss of ascorbic acid, and others. Shelf-life related changes in the index of deterioration correlate with quality loss.

When you conduct the shelf-life tests of your product, it would be better to carry out sensory evaluation of the quality factor with at least one chemical, physical or microbiological measurement.

MANUFACTURING TO TEST MARKET

As an initial part of your business plan, it would be a good idea to consider manufacturing certain large volume of product for the test market. A typical test market will represent a small percentage of the anticipated market but usually more than what you could produce in your small scale. In such cases, some outside assistance may be required.

University, equipment vendors or government research organizations may be available for pilot production and testing. This approach is useful sometimes because they specialize in product and process development. Furthermore, they have good access to pertinent information on the area of research and development as well as regulatory requirements.

Another option for test manufacturing would be co-packers or co-manufacturers. Co-packing may be useful because it can reduce capital expenditure by using existing facilities and equipment, can accelerate schedules, can draw on relevant expertise, and can provide a useful learning experience. On the other hand, there is a risk of exposing proprietary information, and operation costs may be relatively high because the co-packer will expect to earn a profit.

You may decide to construct a new facility from scratch for test market production. This usually requires the highest cost and takes the longest time, but it stands a better chance of achieving the optimal design and keeping the greatest confidentiality.

By the time you have done your test manufacturing, you would know how the whole production can be carried out. You can anticipate what kind of problems that could arise and know how you can tackle these problems in the actual large scale production. In addition, you would be able to determine what consumers' expectations are on your product and would be able to adjust it to meet their expectations.

QUALITY ASSURANCE AND FOOD SAFETY

In large scale production, your primary objectives must be to maintain consistent quality of your product, and to manufacture safe and wholesome product. Safety could be ensured through routine testing and product/process inspection. The following are various quality programs commonly being implemented in food industry.

Code of Practice:

Health Canada's "Code of Practice - Principles of Food Hygiene for Use by the Food Industry in Canada" is internationally recognized practices and procedures which guide food processing conditions and plant environments to assure the production of safe and wholesome food. It covers general hygienic practices for growing, harvesting, processing, packaging, storage, transport, distribution and sale of food for human consumption.

Good Manufacturing Practice (GMP) Guidelines:

The GMP Guidelines are based on the "Code of Practice - Principles of Food Hygiene for Use by the Food Industry in Canada." Each regulation is presented with a rationale and details of compliance under sections of interpretation.

With increased consumer awareness and regulatory demand, all the food processors are required to comply with the regulations. Food processors are encouraged to take a full responsibility for their product safety. The GMP Guidelines include assuring proper quality management of the following areas: premises, equipment, personnel, manufacturing controls, sanitation program, records, recall, transportation and storage.

Hazard Analysis Critical Control Point (HACCP):

The HACCP programme was first developed by the Pillsbury company in 1960's for the space programme in the US. It is a system of assuring food safety by preventing hazards in the finished product, there are seven steps to setting up an effective HACCP programme:

- identify food safety hazards;
- establish critical control points;
- establish critical limits;
- set up monitoring procedures;
- take corrective actions;
- set up verification and review procedures;
- establish record keeping system.

ISO 9000:

ISO 9000 is a quality management system for all manufacturers and is recognised worldwide. The system is aimed at preventing and detecting any non-conforming product during production and distribution to the customers through the development and use of specifications for ingredients, processes and finished products. When a non-conformance is detected, corrective actions take place as an effective part of the system.

Both GMP and HACCP programmes build quality management toward ISO 9000 system requirements.

Food Quality:

Assuring quality of your product is fundamental to the success of your business. The food products that people choose to purchase and consume depend largely on quality and consistency of quality. Controlling the quality of your product requires: 1) defining

which attributes are of critical importance to your consumers; 2) determining limits on those attributes; and 3) establishing a means to ensure those attributes are maintained within the limits during processing.

REGULATORY COMPLIANCE

Often times the recipe must be reformulated to comply with provincial, federal and international food regulatory agencies. Provincial inspection and licensing are required if your company intend to sell only within your province. Federal registration and inspection are required for companies intending to sell their product beyond their provincial borders. Usually, federal inspection requirements are more stringent than provincial ones.

Your product usually would have to include some or all of the following information:

- the standard of identity (product name);
- ingredient declaration;
- net weight or volume;
- expiration dates and storage information;
- serving suggestions;
- company name and address;
- licenses or registration;
- nutritional labelling;
- health claims or consumer education;
- safety instructions (e.g. on how to open package or how long to leave the product in the microwave oven after cooking before removing it);
- quality declarations;
- UPS symbol.

If your product is to be sold in the US market, the product must consist of all GRAS (Generally Recognized As Safe) ingredients that are sanctioned by the FDA for use in that particular food. When the food product contains any meat or seafood components, the complexity increases because it will be considered a high risk product.

In the past two to three decades, governments are striving to get away from traditional inspection functions and move towards the audit of food safety management system within the food companies. The use of Hazard Analysis Critical Control Point (HACCP)

system is generally recognized as the most effective means of managing food safety. In addition to the regulations on food products, the government agencies impose regulations pertaining to food manufacturing establishments in the areas of sanitation, building materials, and personnel hygiene.

It is useful to talk with inspection agencies to be certain you have all the information required in order to prevent costly mistakes, as the regulatory requirements keep changing, both within and outside Canada.

REFERENCES

1. Food Processors Guide: For Growing Businesses - Atlantic Agri-Products Competitiveness Council, June 1996.

2. Graf, E. & Saguy, S. (1991) Food Product Development: From Concept to the Market Place. New York: Van Nostrand Reinhold.

3. Gray, A.D. & Cyr, D.G. (1987) Marketing Your Product: A Planning Guide for Small Business. North Vancouver: Self-Counsel Press Ltd.

4. Hayes, K., Product and Process Development [Online], Available: http://www.foodsci.purdue.edu/outreach/vap/materials/productprocessevelopment. pdf.

5. Ulrich, K.T. & Eppinger, S.D. (1994) Product Design and Development. New York: McGraw-Hill.