

SECTOR STUDY PROCESSED MANGO



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Funded by
the European Union

This document is part of the mango sector study. This study explores the technical and economic feasibility of different processing and waste valorisation activities. The other chapters are available here: [resources.colead](#)

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1. What is mango purée?

Mango purée is a pulp that is created by squeezing ripe mangoes. The fibre is broken down somewhat and the skins and pips are removed. The final product is a thick purée that is already a concentrate and is frequently shipped without further concentration. To produce a drinkable mango juice, water or juice must be added. However, the purée is also used in a variety of other food products such as ice creams, yoghurt and baby foods.

Mango is different from most other fruits, which tend to separate into solids and liquids when pressed. The juice of mango can be consumed without adding other products. Sometimes a portion of the fibres are added back in the juice later.



Figure 1. Bowl of mango purée

Fruit juices and mango purée are often concentrated through a process of evaporation to reduce transport and storage costs. Later, bottlers of juices will add water back in. They may also add a small amount of concentrate to a juice blend. And they can add concentrate to carbonated water to make fruit-flavoured fizzy drinks. Juice itself cannot be carbonated, so concentrate is needed to give an intense fruit flavour.

The disadvantage of concentration is that volatile flavours and aromas are lost when the product is heated to evaporate the water. However, there are flavour-recovery units that capture these aromas, which can then be either added back into the product or sold as a separate product. Furthermore, in markets where consumers are less sensitive about added flavours, artificial aromas can be added to increase the flavour.

Unconcentrated mango purée or juices are called “single strength”. Concentrated mango purée is often sold as double or triple strength. However, there is no clear definition of what double or triple strength is. The objective standard to indicate the strength of any concentrate is degrees Brix (symbol °Bx), which is the sugar content of fluid. One-degree Brix is 1 gram of sucrose in 100 grams of solution. In the industry this is referred to simply as Brix.

Single strength mango is somewhere between 14 and 18 Brix, double strength is often 22 to 24 Brix and triple strength is around 28 Brix – although it is called triple strength it has only double the sugars.

The Brix of a purée is not only determined by the amount of water that is evaporated, but also by the variety of mango and the growing conditions (soil, sun, etc.). For example, the standard for a single strength purée is 14–18 Brix. Varieties such as Totapuri from India may have only 14 Brix, and Kent or Keitt from South Africa 16 Brix. Mango in West Africa can easily reach 17 to 18 Brix. The higher the Brix, the stronger the purée is perceived to be and the more valuable the product is. However, as mentioned concentration does lead to a loss of certain aromas.

1 What is mango purée?

Each juice has in fact its own standard, and most juices are between 12 and 14 Brix single strength. For pineapple the most popular format seems to be triple concentrate or strength, while orange juice is often more than five times concentrated from 12 Brix to 58 or 60 Brix.

Mango pulp can be packaged and sold in two forms, aseptic and frozen, of which aseptic is the dominant form. Aseptic is much cheaper to store and transport, because no cold chain is needed. Both come in 210-litre drums. Aseptic pulp is sterilised using heat (steam) to kill all bacteria and spores, and packaged under sterile conditions in a sterile bag in a steel drum. It is stable at room temperature and does not need to be transported in refrigerated containers or stored in refrigeration. In contrast, frozen pulp is flash heated, but at significantly lower temperatures than the aseptic product. This enables the product to be pasteurised at a later point in the production process without altering its colour¹ and retaining many of the volatile aromas and flavours. This is especially needed in the dairy industry.



¹ Undergoing a second pasteurisation often results in a discoloration of the product to a greenish hue.

2. Demand

2.1 Overview of the juice market and general trends

The global juice concentrate and pulp market is valued at US\$400 million and is expected to achieve only 5.7% growth in value between 2016 and 2026. North America, Western Europe, Asia and Australasia dominate fruit juice and nectar volumes, with North America and Western Europe accounting for nearly half of the total market (see Figure 2).

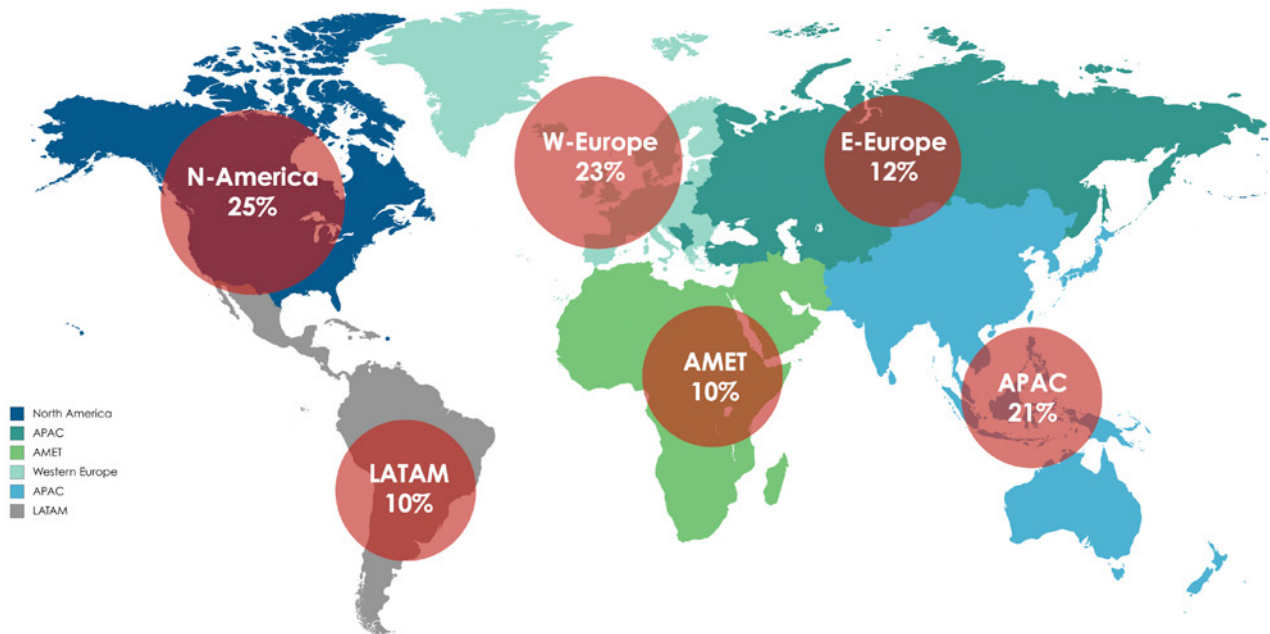


Figure 2. Breakdown of juice consumption in the world 2016. Source: AIJN (2018)

The European juice market is currently largely ambient stable juice (75%) sold in cartons and bottles kept on regular shelves, and 25% chilled juice kept in fridges. However, many juices sold in fridges are ambient stable. They are placed in fridges to give the appearance of fresh juice.

Of all juice (fridge and ambient), 66% is made from concentrates and 34% from fresh juice. About 65% of all juice is in fact a 100% fruit juice, while 35% are nectars, which are fruit juice with water, sugar and other ingredients added. The USA follows similar trends.

However, consumers are increasingly on the lookout for healthier foods, snacks and beverages. They have become increasingly concerned by the sugar content of juices as well the use of concentrates and added flavours, preservatives, etc. As a result, the traditional juice market in Europe and the USA is declining both in volume and value, and these declines are expected to continue.

Many consumers are looking for healthier alternatives and their expectations and buying behaviour have been changing. For this group “all natural” (no sugar or flavour added), juice is mandatory, with many opting for juice that is “not from concentrate” (NFC) (known as “Direktsaft” in Germany, the largest European juice market). Organic is also important among this group of consumers.

2. Demand

As a result, pockets of growth exist in the declining juice market. These help to compensate for the lost volumes from people who no longer buy juice or simply drink less of it. The growing segments are “not from concentrate” chilled juices. However, the traditional juice market remains sizable. Within this market in Europe specifically, private label (juice sold under supermarket brand) is also on the increase. This is part of a wider trend where consumers are becoming more price sensitive. This is partly driven by the growth of discount supermarkets such as Aldi and Lidl.

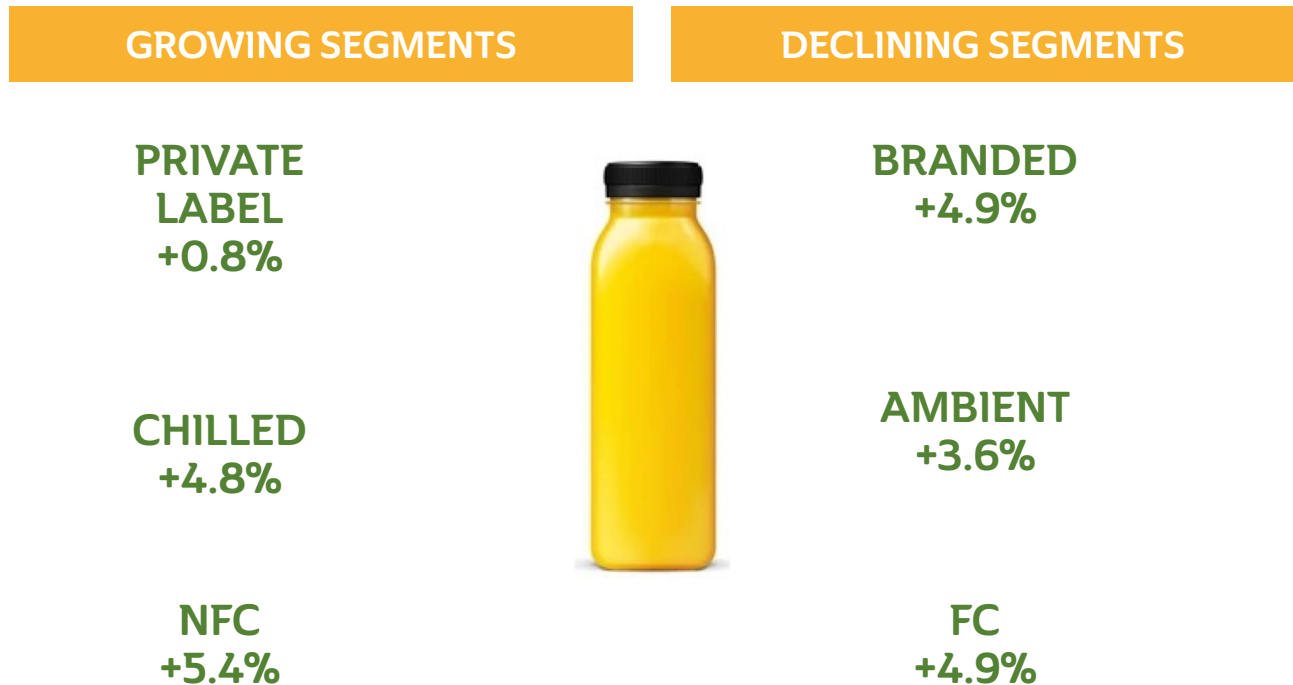


Figure 3. Growing and declining segments in the European juice market, 2016
Source: AIJN (2018)

Although it is widely believed that smoothies are still a fast-growing market, their growth in stores seems to have stagnated according to most importers and experts. As one juice company said, “Whenever we see a new smoothie brand, we wait for it to go bust.” However, it is quite possible that people make more smoothies at home, which would explain the growing presence of frozen berries and mango in supermarkets.

According to some experts there are two segments in most juice markets: a huge but declining number of consumers who just want nice-tasting juice and are less concerned with sugar and preservatives, and a premium segment that wants a clean label, natural juice.

To respond to consumers who are concerned about consuming sugary drinks, many manufacturers have begun to explore fruity beverages as innovation routes. Fruity waters or fruit splashes, fruity beers, fruit-flavoured dairy drinks, etc., have all seen substantial growth. This has in some measure compensated for the declines in the beverages market. As result, while fruit juices have declined in volume, imports of fruit pulps to Europe and USA have remained stable.



Figure 4. Fruity beverages

There are many competitors in the declining juice market. It is not unusual for a single market to have many brands on offer, with a wide range of products. Global players such as Coca-Cola and Pepsico, regional juice players such as Granini, local heroes such as Riedel in the Netherlands and very aggressive private label manufacturers such as Refresco are all common competitors in a single market.

This intense competition has meant that brands have had to look for differentiation to stay ahead. Innovation has become an important tool for manufacturers, who have consequently experimented with a wide range of new product introductions. They have tried functional benefit claims (e.g. “for energy”), quality claims (e.g. cold pressed juices), new product formats (e.g. smoothies), as well as packaging and ingredient innovation. Many have attempted to differentiate themselves from their competition by bringing new flavours to the category. As a result, tropical fruit flavours have become a core part of the flavour line-up for many brands and sit alongside berry, apple and pear as firm favourites.

In Germany in particular, mango and maracuja (a type of passion fruit), seem to be “on-trend” and a flavour combination that extends to tea, lotions, hand soaps, etc. This innovation grew the exotic fruit juice and pulp trade to US\$400 million globally in 2017 and is expected to grow at a fair pace until 2026.

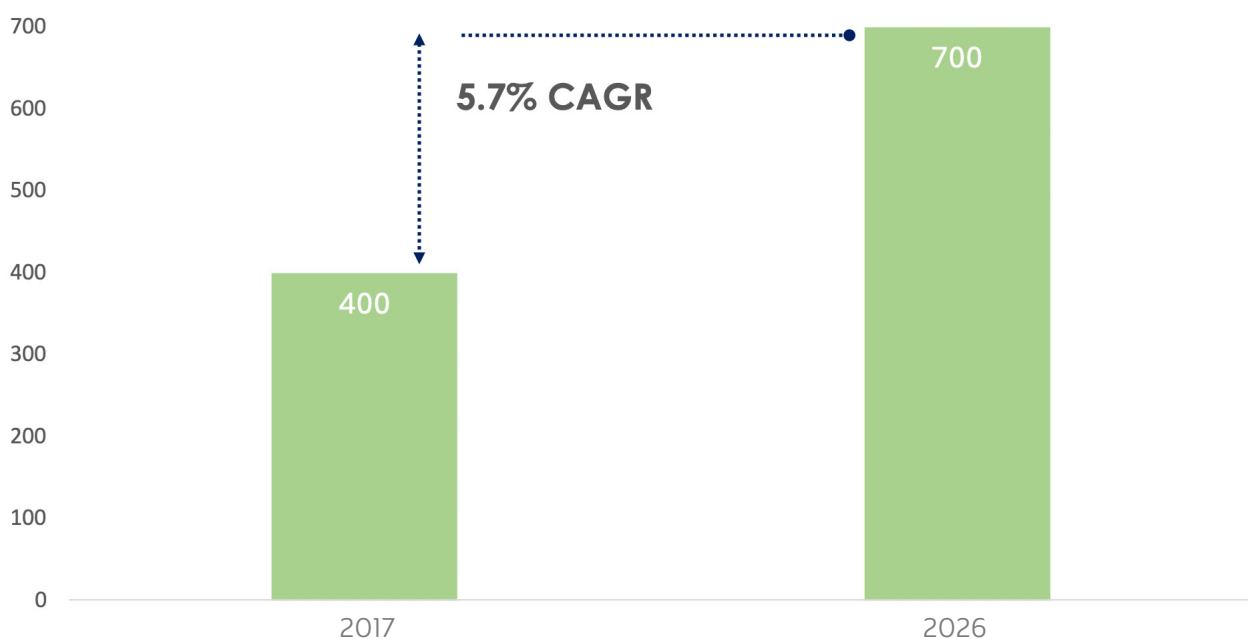


Figure 5. Exotic fruit drinks – actual and projected market size

In conclusion, mango is a growing market segment in the declining juice market.

2.2 Other uses of mango purée and concentrates

Mango purée has many other uses beyond the juice market. It is used industrially as an ingredient in ice cream, smooth yoghurts, smoothies, baby foods and jams, and as a sweetener in a wide range of snacks (e.g. snack bars). It is also increasingly used to add flavour to white vinegar to create premium mango vinegars. Fresh and IQF (individually quick-frozen) mango pieces are relatively expensive. So, using purée allows companies to design mango products that are more affordable.

In more premium products, especially where the texture of mango is needed, IQF cubes are more likely to be used in preference to or alongside purée. Mango purée is very smooth and lacks the texture that is needed in these recipes. Yoghurts where you can see and feel real mango pieces are one example of products that typically include real mango pieces. In this premium product, manufacturers would choose to use IQF mango pieces, which provides a chunky texture, but is easier to handle than fresh mango. Nevertheless, as mango purée is cheaper and easier to work with, this is generally included in the recipes of far more expensive or textured products too. Each company does a cost–benefit analysis and decides on whether purée, IQF cubes or what balance of the two ingredients depending on the desired flavour, texture and end price of the product they are designing. The exact ingredient choice or balance will be a trade secret.

Figure 6 shows a range of products found in US and European supermarkets that contain mango. It is not always possible to see from the outside whether mango purée is used or a preparation based on frozen mango cubes.



Figure 6. Examples of foods prepared with mango purée

2.2.1 The African market

The juice market in Africa is fundamentally different from that of other continents. Consumption of packaged juice is very low, and as such Africa is the last frontier for global juice companies.

From a supply perspective, there are very few industrial bottlers active in Africa. Most juice available is actually imported by traders by the container load. Importing in retail packaging makes the product very expensive. What is imported is usually a brand and product for which there are cheap overstocks available somewhere. This is why there are often changes in the brands available. Some of the more regular brands are imported from South Africa (Ceres) and Spain (Don Simon). Egypt and other countries in the Middle East are also regular suppliers.

Local production in Africa is usually limited to small artisanal producers who purchase first grade fruit, and process this in an artisanal or semi-artisanal way and bottle in second-hand



glass bottles, because they are easy to sterilise and hot fill. Often sugar is added to improve the flavour. Production is seasonal and, because shelf life is limited, sales are also seasonal. Each producer tends to have 3 to 10 different flavours. The distribution of product from these companies tends to be limited to a few shops, restaurants and hotels, and occasionally one or two wholesalers. The production in these companies is also quite small as each company will typically produce somewhere between 50,000 to 100,000 small bottles per year.

This business model has many challenges. First, it is difficult because a juice producer must manage everything from raw material to retail sales. Second, the production is usually limited by the number of second-hand bottles available. Recyclers have limited numbers of bottles to sell, and most juice producers are forced to set up a collection system for second-hand bottles. Third, the packaging cost are usually about 50% of the cost of production, making the product two to four times more expensive than, for example, locally bottled soft drinks. The fact that first grade fruit is used further increases the cost of production.

Juices in Africa, both imported and locally produced artisanal juices, are luxury products and distribution tends to be limited to upmarket conveniences stores, often in petrol stations, and a few supermarkets.

A challenge in the marketing of juices in Africa is that from the perspective of most shoppers fruit-flavoured sodas, juice cordials, nectars and pure fruit juice are quite interchangeable, but anything that is not 100% fruit is much cheaper. Many consumers do not understand the difference between a fruit juice and a nectar, or a drink with artificial flavouring. Part of the reason is that in most countries there are no strict packaging laws that prevent producers using images of fruit on the label if there is no fruit inside, or these laws are not enforced. And many consumers are not able to read and understand labels.

Local soft drinks can be much cheaper because they are basically an artificial flavour blended with water or carbonated water. No pasteurisation is needed, which means it can be cold filled in cheap PET (plastic) bottles. This is feasible on a relatively small scale. Industrial bottlers, on the other hand, often bottling under licence of Coca-Cola or Monarch, have the advantage of scale. An industrial PET or Tetra Pak filling line typically handles 20 million litres per year.

The number of industrial fruit juice bottlers is increasing in Africa, albeit at a slow pace. For example, there are now two bottlers in Burkina Faso, though they combine their businesses with purée export. Senegal has had an industrial bottler, Kirène, for a long time, that has recently opened a new plant in Côte d'Ivoire. In Mozambique, the Portuguese company Compal opened a plant. South Africa and Egypt have had multiple juice bottlers for a long time. Typically, these bottlers import all their juices and concentrates from outside Africa.



2.3 How do juice bottlers use mango purée?

Pure mango juice is not available on European and US markets. Because mango purée has a very thick texture, it needs to be blended with water to produce a drinkable juice, and then sugar needs to be added to improve the flavour. This means it cannot be sold as a juice but needs to be labelled as nectar, which decreases its marketability. Furthermore, mango as a stand-alone flavour is probably too particular for the European market. Mango purée is therefore only used in juice blends.

Juice bottling is in fact the art of blending. Bottlers try to create a great tasting juice at the lowest price, while being able to make interesting claims on the packaging around ingredients that will attract the attention of shoppers. Each juice bottler decides on what to buy based on the cost and the flavour profile they want to achieve with their product.

To manage costs in a fairly price-sensitive market, most companies blend readily available, cheaper juices with a more expensive claimed ingredient. Grape, apple and pear juice are popular base ingredients in juice blends. These ingredients tend to have a neutral flavour. Though it has a more distinct flavour, orange juice is also used as a low-cost base or filler. More expensive ingredients with distinct flavours or an interesting image, such as mango, are used in smaller quantities to add a distinct flavour and spark the interest of consumers. They are always claimed on the pack. In some instances, minute quantities are used, just so the ingredient can be claimed.

Most mango juices on the market contain only between 5% and 20% mango. Mango is frequently blended with orange juice, as well as other tropical juices such as pineapple. Pineapple itself sits somewhere between a cheap base and a claimed ingredient as it is not as expensive as mango.

Companies are constrained by regulatory requirements around claimed ingredients and mandatory ingredient labelling legislation. For example, organic claims must meet European legislation and must ultimately carry the European organic logo. Juice made from concentrate must state this on the pack. Blends of two ingredients must be named on the pack in descending order of contribution to the blend and three or more may be called a “blend of fruits”.²The ingredients must be indicated on the ingredients list and shown in order of content.

² <https://eur-lex.europa.eu/EN/legal-content/summary/fruit-juices-and-similar-products.html>

When it comes to the choice of which and how much mango purée to use, bottlers need to make a trade-off. The stronger the purée (in sugar content or Brix) and the stronger and more pronounced the flavour (mostly determined by variety, but also whether it is single strength or concentrated), the less you need of the product in your blend. For example, bottlers can choose to use 5% of Alfonso variety single strength at US\$1,400 or 10% of Totapuri at US\$700 to end up with a strong mango flavour. Because of lower transport cost, triple strength will be cheaper to use, but may give less mango flavour.

Another concern when blending is how the flavour can be kept consistent throughout the year. Most shoppers expect the product to taste the same from season to season, and year to year. But fruit is seasonal, and different varieties and countries produce different flavours. Even the same variety from the same origin can taste different from one season to the next. Most bottlers thus work with food ingredients companies to blend varieties and origins so that they can match the flavour profile consistently. This is crucial as significant changes to the ingredients need to be reflected on pack. Making these changes is operationally complex and can be costly.

2.3.1 Buying criteria overview

Variety and Brix are the two most important and objective criteria used to determine the sales price of mango purée. Together, they give a buyer an indication of the colour, flavour and strength of the purée. This then affects how much purée is needed in the mix. The variety is an especially important factor in final flavour as it affects sugar content, aroma, flavour and colour. So, variety is often used as an indicator of the final flavour.

The method of packing also affects demand for the product and the price. Aseptic packing makes for a cheaper, more stable product, but some aromas and flavours can be lost in processing. So, the more expensive frozen purée is sourced by companies looking to make products that need pasteurising in the final stages of production. This is typical of dairy products. The higher flavour intensity and cost of logistics also attracts buyers who are looking to produce a premium product packed with flavour.

Other buying criteria are the certification (see section 2.3.3), the season and the quantity that can be supplied. The minimum quantity is a 40-foot container that holds about 21 tonnes. However, most serious importers want a large number of containers. It is not interesting for them to have many different small suppliers. The season can be of interest, especially if it is different from India.

2.3.2 Variety and prices

All the prices in this section relate to single strength aseptic purée including transport to a port in the US or Europe (i.e. cost and freight, CnF). Frozen purée tends to be more expensive because of the higher transport and storage costs and the different production process. In addition, frozen purée requires special equipment to process it. The price difference is often around US\$100 per tonne.

The most common variety in India and on the global market is Totapuri, and this is also the cheapest product on the market. Totapuri sold for around US\$550–750 per tonne for conventional single concentrate (August 2022), depending on the season. In a good season, there is no destination in the world that can compete with Totapuri on price. It does not have a particularly interesting or strong flavour and is usually 14–15 Brix. A “triple strength” Totapuri of 28 Brix is double the price of the single strength. Kesar is another Indian variety



that is comparable to Totapuri in terms of price and flavour. More recently, Indian companies have been looking to bring table varieties to market. But these are still being tested on the international market.

Totapuri is mostly used in cheaper juices and food products, and is often sold as a double or triple concentrate to reduce transport costs. It is, to a certain extent, used to be able to claim that a product contains mango. But the lack of flavour means that either more is needed, or an aroma needs to be added (which is more common in the Middle East).

The most expensive mango variety in the world, Alphonso, is still considered to be the gold standard for colour and flavour – there is no other variety that rivals Alphonso. It also comes from India and usually sells for US\$1,200–1,600 per tonne. But when there is a bumper harvest, the price can drop to US\$1,000, and then it becomes more difficult for other varieties to compete, and thus prices of, for example, Kent and Brooks also fall. These days the market seems to distinguish between Northern Alphonso and Southern Alphonso, which is more aromatic and slightly more expensive.

In-between varieties such as Chato d’lca (grown in Peru), Palmer (Brazil), Tommy Atkins, Kent and Keitt (Ecuador, Mexico, South Africa), Magdalena (Colombia) and Brooks, Lippens and Amélie (Burkina Faso and Mali) can fetch anything between US\$700 and US\$1,000 per tonne. For most varieties such as Kent, Keitt, Tommy Atkins and Amélie, single strength will sell at around US\$750–850.

Samples are always needed for factories so they can test the strength, colour, flavour and aroma. This is not only determined by the variety, but also by growing conditions (soil, sun, water, orchard maintenance) and processing equipment and management. For example, Kent and Keitt mango in West Africa are said to have a more intense flavour and a higher sugar content than in, for example, Peru and South Africa. However, if the purée is sterilised at excessively high temperatures or for too long, aromas may disappear, the colour gets darker and there may be flavour notes of burned purée.

2.3.3 Certification

Because most purée is used by large bottlers selling to supermarkets, HACCP (hazard analysis and critical control point) certification is essential and considered a minimum. However, IFS, BRC and FSCC 22000³ (based on ISO 22000 and 22003) are increasingly demanded. There seems to be no real growth in demand for fair trade purée.

Most retailers do not accept processed product that is not certified. And selling uncertified product is a risk. If something is wrong with the product, the bottler needs to pay for all the product to be removed from the shelves and replaced. It is also crucial that if something happens, the bottler can show they tried to manage the risk by working with certified suppliers. HACCP is regarded as the barest minimum, while the others can provide more opportunities.

Organic certification does not say anything about the food safety of a product and is therefore not a replacement for HACCP or BRC. It is, however, important to sell in the growing organic juice market.

2.3.4 Organic market

There is a strong demand for organic purée, and production lags supply. As a result, organic purée can achieve a small, but interesting price premium. It is typically marketed for US\$100–150 per tonne more than a medium-quality, conventional purée such as Single Strength Kent. So, if this Kent product is US\$1,000 per tonne, then organic Kent will be US\$1,100–1,150 per tonne. Entering the market for purée is generally challenging, but those with organic purée are much more likely to find a buyer.

2.3.5 Single versus double and triple strength

The minimum strength for a single-strength purée is 14 Brix, but 15 or 16 Brix is common and considered much better. In West Africa, however, sugar content tends to be higher, often 17–18 Brix. Double strength should have a minimum of 20 Brix, while 28 Brix is often called triple strength.

The main advantage of single strength is flavour, and the fact that it can be used for NFC juices. This is a growing market segment because consumers believe it is healthier and a better product.

The main advantage of double or triple strength pulp is reduced transport costs. A company can in principle make the same amount of juice from one container of 28 Brix purée as from two containers of 14 Brix purée. Assuming the transport cost for a 20-foot container that can take 17 tonnes is US\$2,500, this means that the cost savings on 24 tonnes of single strength equivalent purée are US\$2,500, or US\$73 per tonne. This is a saving of 15% if you would be buying, for example, Totapuri pulp at US\$500 per tonne for 14 Brix and US\$1,000 for 28 Brix. However, on an Alphonso purée of US\$1,400 per tonne for single strength it is not nearly as interesting, particularly because one buys Alphonso because of the better flavour, that then partly disappears if you concentrate it.

³ International Featured Standard, British Retail Consortium and Food Safety System Certification 22000.

2.3.6 Shelf life

Frozen purée has a typical shelf life of 18 months. Nevertheless, most buyers prefer product with at least 6 months shelf life remaining. This enables better control of cold chain. This consideration is particularly important for buyers who are looking to use purée in desserts and foods that require a finer texture (e.g. baby food).

Aseptic purée has a typical shelf life of 24 months. It can develop a darker in colour over time. So, most buyers also prefer product that has at least 12 months remaining on the shelf life.

24 Packaging

Bag in Box Packaging for smaller shipments



Shipping Drums on Pallet

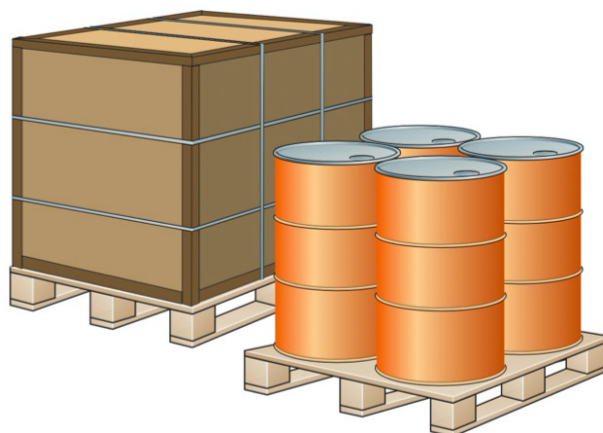


Figure 7. Packaging options for fruit purée
Source: Tetrapak's Orange Book.

Fruit purée and juices and concentrates tend to be shipped in drums that are double lined with plastic sheeting. These are available in 230 kg (215 litre) and 1,000 kg sizes. These are then palletised and shipped. Larger volumes of juice are sometimes shipped using a tanker. Some juices can also be shipped in a bulk bag that fits in a container.

However, for mango the standard seems to be in aseptic bags in a 215 litre metal drum. Because the product is used in smaller volumes, bulk transport is not common. In fact, most bulk transport is used for the bases such as grape, apple and orange juice, as well as for not from concentrate.

For smaller shipments, a smaller box filled with a PET bag is used.

2.5 Market trends

2.5.1 Sugar reduction

Sugar reduction has become a mass trend in developed economies. It is also gaining traction in Africa and other developing markets. The juice sector has paid a heavy price. Nutrition advice now includes recommendations to reduce or remove juice from your diet, especially among those with diabetes or insulin resistance. This has driven declines in the core juice market.



Figure 8. Reduced-sugar drink

2.5.2 Lightly processed

Health-conscious shoppers are increasingly choosing whole foods over processed foods. To them eating an apple is significantly healthier than apple juice. Yet even trend provides opportunities. Some shoppers are content with choosing lightly processed versions of their favourite food and juices. In the case of juices this could be “freshly squeezed juice”, “cold pressed”, “not from concentrate”.

At the same time manufacturers have been working hard to cue that these products are lightly processed and fresh. These types of juices tend to be merchandised in the fridge or in the fruit and vegetable section of the store. In the case of freshly squeezed juices, equipment to squeeze the juice from oranges is in the fruit aisle and this is done on request using oranges from the shelves. Transparent glass and PET bottles might also be used to give a fresher, more transparent feel to the product.



Figure 9. Organic, cold pressed juice, UK

2.5.3 Vegetable juice blends

Several food trends – such as low carbohydrate, whole foods and plant-based ways of eating – emphasise the importance of including vegetables in one’s diet. Growing interest here has allowed manufactures to build on a previous trend around juicing. Vegetable juices, which were once a very confusing concept, have moved from being a specialist product to the mainstream.

Today, a range of vegetable juices are included in the blends of mainstream brands. Carrot, beetroot, celery and cucumber are some of the more common flavours. These vegetable purées are also sold on to the food manufacturing sector.



Figure 10. Advertising poster from a leading Dutch juice brand

2.5.4 Local heroes

Shoppers tend to perceive local ingredients as fresher, more wholesome and generally more authentic. So, as manufacturers look to innovate their way out of the declining demand for juices, they are also looking to local flavours and ingredients. In India, turmeric might be added to a recipe. In the UK, this trend plays out with juice manufacturers including elderflower in their recipes. In other countries, this might include claims of local or regional origin. Valencia or Seville orange juice point to EU sourcing origins.



Figure 11. Apple and elderflower juice from Waitrose, UK

2.5.5 Vitality boosting

Health and wellness continues to be an important trend among shoppers around the world. The intense focus on immunity during the COVID-19 pandemic only intensified this trend. Manufacturers have responded by introducing new ingredients that reinforce health and can allow for health or vitality claims. Some innovative concepts include vitamin blends, charcoal, added herbs and spices such as turmeric or ginger and increasingly kombucha.



Figure 12. Fruit Juice Shot from Albert Heijn (AH) Netherlands

2.5.6 Sustainability and ethical standards

Sustainability is of growing importance to juice shoppers and to retailers. This has inspired companies to introduce various sustainable production and business practices. First, companies increasingly opt to use bottles made from recycled plastics. During processing of the juice itself, many companies are working towards zero-waste models, with many attempts to introduce circular production. This is where waste is minimised and they aim to convert waste into valuable products such as compost or biogas. Companies are also striving for ethical production. Many have invested in supporting local communities. Others have invested in membership of the Rainforest Alliance, or in Fair Trade certification – although the second is of decreased popularity in the juice segment. Many companies have opted to make this a part of their brands and have taken this under their own control. Finally, as energy and water are hot topics, several companies are investing in converting to using sustainable energy, reducing their carbon footprints and even in researching farming practices that allow for farmers to reduce the water they need in growing produce.



Figure 13. Billboard from Innocent Drinks UK with recycling message

3. Supply

3.1 How do these products reach the market, what is the structure of the value chain?

The value chain is relatively short, with factories in the tropics generally selling directly to food ingredients companies and specialist juice companies (also known as compound houses). The factories might sell directly to juice bottlers and food manufacturers. In some cases, importers or agents/brokers are involved in linking producers to compound houses or food manufacturers.

Compound houses (also referred to as prep houses in the USA) are importers that store, blend and, in some cases, slightly modify juices and concentrates and can supply natural and artificial aromas. They deliver a standardised product to food manufacturers year-round that can be used as an ingredient in a final product and packaged. Compound houses also help companies develop products that meet their targeted flavour profile, product specifications and the price point, and help with product formulations.

The compound houses often work with several factories in Asia and Latin America, and occasionally in Africa, to have year-round supply and access to different varieties of mango with their own unique flavour profiles. They also order some quantities via importers or brokers, particularly if the products are in short supply or the compound house is asked to source specific products, such as organic or different varieties.

Not every juice or food company uses compound houses. Some companies, usually the larger ones, have a lot of knowledge in-house and are comfortable buying directly from factories with which they have a long-term relationship. They typically secure a large part of their need via contracts and use importers or compound houses if they need more products.

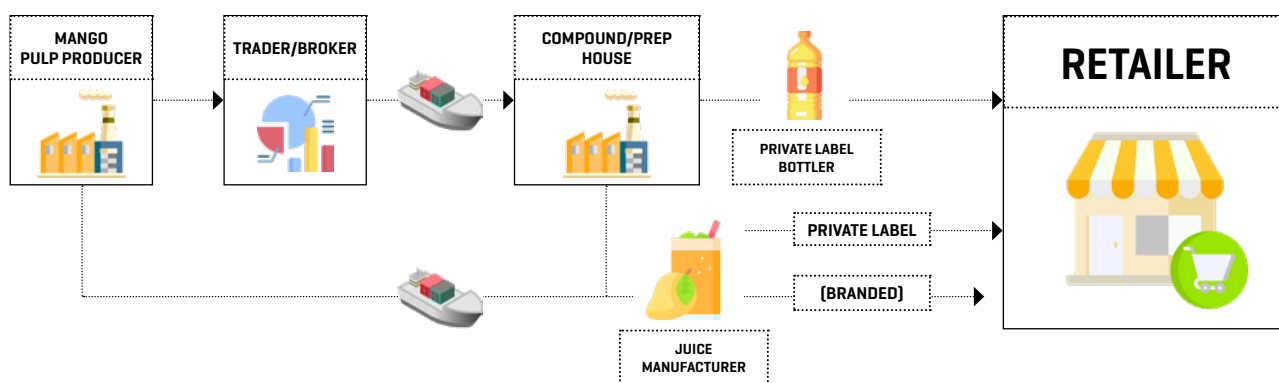


Figure 14. Structure of the pulp/purée market

Since the early 2010s, the industry has experienced concentration, globalisation and vertical integration. Importers and compound houses, food companies and juice companies are merging and increasingly operating globally. Compound houses and importers are also increasingly investing in their own mango purée factories or developing joint ventures or strategic partnerships with open book calculations and long-term contracts. This means the importance of traditional intermediaries such as agents and brokers is decreasing.

These developments also mean that many of the same companies that operate in Europe now also operate in the USA, and the markets are becoming more and more global. Pepsico (Tropicana) and Coca-Cola (Minute Maid, Innocent Smoothies), for example, now have a growing presence across Europe and elsewhere in the world and can be found in every supermarket in Europe. Refresco acquired and merged with about 13 local juice companies across Europe between 1999 and 2016 to become the biggest soft drinks and juice bottler in Europe. In 2018, they bought Cott's bottling activities in North America and the UK, and now have a production capacity of 12 billion litres with 59 facilities in 12 countries.

3.2 Suppliers in the market

The biggest producer of mango purée in the world is India, which has many large factories that churn out 20,000 tonnes per season. It is nearly impossible to beat India on price when they have a good crop. India sells mostly to the Middle East and Europe, though it is also the third largest supplier to the USA.

Mexico is the second biggest producer, and the biggest supplier to the USA. It also operates many large-scale factories. It has been a traditional supplier to southern Europe for a long time, but is starting to become more important across the whole Europe.

Colombia is the second biggest supplier to the USA, but in Europe it is mostly known for specialty varieties such as Magdalena. Its export volumes to the USA have seen strong growth over the past years.

Peru, Ecuador, the Dominican Republic, Brazil, Thailand, the Philippines and South Africa are all producers of mango, but in much smaller quantities than India. Finally, Mali, Senegal and Burkina Faso all have mango purée factories, but the scale is small and export volumes are so modest that most buyers are not aware of them.

3.3 Seasonality

Purée is sourced from various origins around the world. Its longer shelf life allows buyers some flexibility in the timing of when they source purée. However, in general they prefer to source and lock in purchases in line with the global sourcing calendar for the fresh fruit. This provides better control of colour and enables a more predictable supply chain.

As a result, in the earlier parts of the year importers look to source purée from Brazil, Peru, Ecuador and South Africa. Thereafter, in the second quarter the focus moves to Costa Rica. Mali and Burkina Faso are also exporting fresh mango at that time, but they tend not to produce and export purée.

Towards April, Côte d'Ivoire and Mexico begin to export fresh mango. This time of year is on the fringe of the Indian season. Then India comes into production. India exports both fresh mango and purée. This is a major purée production season globally, especially as India produces large volumes of low-cost Totapuri purée. It also supplies Alphonso for about 3 months starting in May.

In the third quarter, Senegal and Israel are exporting fresh mango, before Spain comes into production.

	J	F	M	A	M	J	J	A	S	O	N	D
Brazil												
Peru												
Ecuador												
South Africa												
Costa Rica												
Mali and Burkina Faso												
Côte d'Ivoire												
India (Totapuri)												
India (Alphonso)												
Mexico												
Dominican Republic												
Pakistan and India												
Senegal												
Israel												
Spain												

Figure 15. Overview of mango season in key countries

Purée production can comfortably be accommodated by countries that export fresh, frozen or dried mango. Mango purée is often made from second or third grade fruit, or fruit that is cheap to produce, such as Totapuri.

In most fruit sectors, first grade fruit is for export or premium local markets. Second grade fruit, which may show some skin blemishes and a little discoloration, is used for the local fresh market, fresh fruit salads, drying and freezing. Third grade fruit, which can be too large or small and unattractive, is now only used for processing. Finally, fruit that is too ripe for fresh cut salads, IQF or dried fruit can still be used for juice. Only severely infected (diseased) fruit cannot be used because the fruit is pulped whole and there is no time to cut out infected parts. Infected fruit normally affects the flavour.

Because purée is an internationally very competitive market that requires scale, a factory needs to have access to large volumes of cheap fruit. Consequently, some countries such as Senegal and Ghana cannot be competitive because the price of mango there is simply too high.

3.4 Technology, processes and techniques

Fruit purées are rich in sugar. This requires specialised equipment for preventing spoiling.

3.4.1 Stage 1: Reception, washing, sorting and ripening

At reception a visual inspection of the fruit is done. The fruit is then washed in a water bath that can be dosed with chlorine or other products. It is then sorted, and any infected, overripe or rotten fruit is removed. Usually, this fruit can be collected by the supplier and is not paid for (it is excluded from the producer's remuneration). Accepted fruit is then ripened – in crates in a hall or outside under a roof, or in specialised ripening rooms.

Some factories will sort and ripen before washing. However, for more even ripening and

lower ripening losses, all fruit should be washed first.

3.4.2 Stage 2: Pulping

This is where the mango is mechanically squashed to separate the pulp, peel and pip. At the start of this stage mango may be washed again. Whether or not it is rewashed, it is sorted

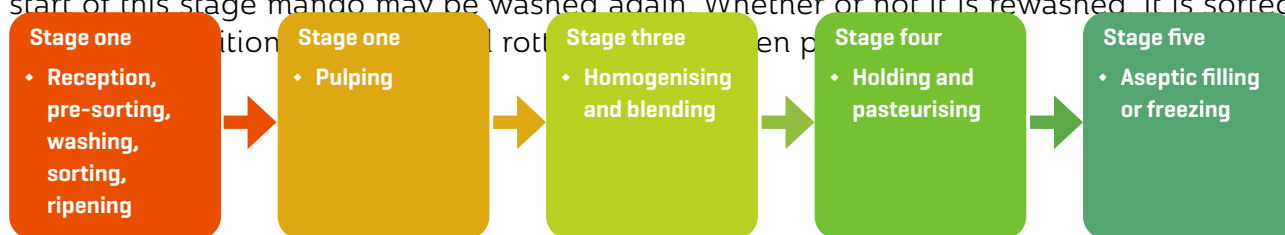


Figure 16. Typical purée processing stages

3.4.3 Stage 3: Homogenising and blending

The pulp is pushed to the next vessel, where a second pulping phase takes place to blend or homogenise the mango purée.

3.4.4 Stage 4: Holding and pasteurising

If the product is frozen, it is flash heated to 90°C in a pasteuriser, and then chilled to below 10°C. If the product is aseptically filled, the sterilisation process will happen in the aseptic line prior to filling. Product that is concentrated is put through an evaporator.

3.4.5 Stage 5: Aseptic filling or freezing

Referring to Berlin Packaging, aseptic filling is the process of filling commercially sterilized products into pre-sterilized containers. For aseptic filling, product is most often packed in aseptic bags, which are sealed and placed in 210-litre or 219-kg drums for transportation. Should the customer require such, smaller aseptic bulk bags in boxes are an option.



For freezing, the mango purée is packed into double-walled foil bags and frozen.

3.4.6 Technology

For processing mango purée, a line with various components is required. These are shown in Figure 17. The most important and expensive machinery in this line is the pulper and the homogeniser/blender.

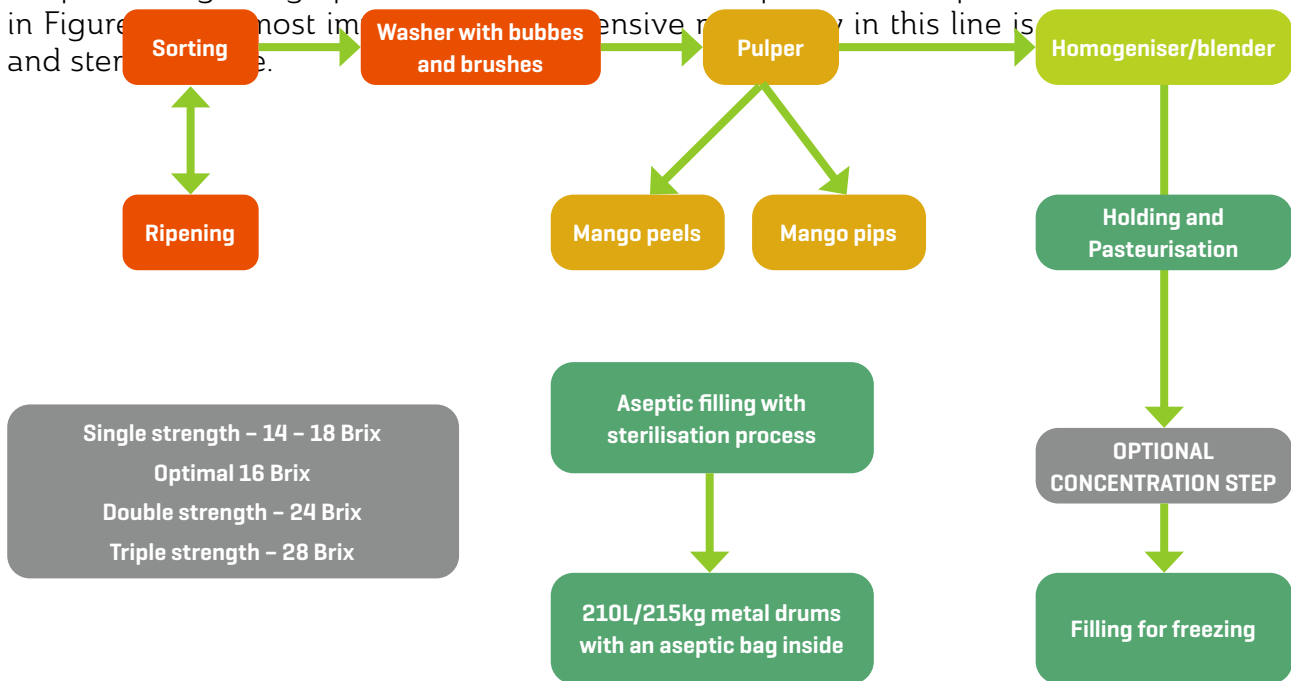


Figure 17. Purée processing with technology

- The smallest production line available is 5 tonnes of fresh mango per hour, though the actual capacity is between 4 and 5 tonnes. This depends on the speed at which the line is fed, which in turn depends on loading but also the speed of the sorting team behind the sorting belt. In addition, the pasteurisation and evaporation time needed influences the speed.
- Yields range between 55% and 65%, depending on the variety, size of mangoes, quality of mango and losses during the ripening process. For economic calculations, 58% should be taken for new factories and 60% for existing plants with qualified staff and good supply chain management.
- Production lines can be sourced from India and China, but the quality and availability of parts is not reliable, so the best option is to source from Italy, where there are at least two reputable suppliers.
- To set up a plant, a minimum of 1 hectare of land is required, which would need to be fenced. The buildings house the production line, an office, a small laboratory, ripening rooms, and final product storage.
- The production line needs an additional boiler for steam that is fed to the concentration and pasteurising units and a generator for backup electricity. These are normally sourced from separate suppliers.
- The approximate cost of setting up a processing line is detailed in Table 1.

Table 1. Approximate production line costs

Equipment	Number	Unit price (US\$)	Cost (US\$)	Month of purchase	Lifetime (years)
Juice processing line Bertuzzi	1	1,629,080	1,629,080	6	10
Generator	1	28,000	28,000	9	10
Boiler for steam	1	28,000	28,000	9	10
Lab equipment	1	28,000	28,000	9	10
Pallet jacks and small equipment	1	28,000	28,000	9	3
Plastic crates	55,000	6	302,500	12	3
Total			2,043,580		

When concentrating mango purée, flavour is lost through volatile oils. Installation of a flavour-recovery unit is a consideration to keep the standard of the purée high. Alternately, what evaporates can be sold as mango extract. The cost of a flavour-recovery unit would be between US\$50,000 and US\$100,000.

Usually, the cost of the land and building are 50% of the total investment cost, with equipment accounting for the other 50%. The total cost of a mango purée plant is around US\$4 million. The production can normally be doubled or tripled by adding one or two lines in parallel. The building design and services (e.g. boiler) should be done in a way that extra lines can be added.

3.5 Ingredients for success

3.5.1 Make a choice between bottling or juice, but do not mix your drinks

The most common mistake in Africa is that entrepreneurs want to produce juices from fruit and bottle and sell them. However, these are two distinctly different business models that are separated in most of the world for a good reason. They both require large scale and large investments to be competitive.

Juice producers or plants purchase large amounts of fruit and produce an intermediate or industrial product that they usually export. They are focused on supply of fruit, processing and business-to-business marketing. They go to trade fairs to find clients. They need focus to reach scale, because the minimum size of a line is 5 tonnes of fresh fruit per hour. They need to produce about 10,000 tonnes of juice and concentrate per year to cover their fixed costs. They usually focus on two or three juices. As already noted (section 3.4.6), the minimum investment is around US\$4 million.

Juice bottlers on the other hand never touch a piece of fresh fruit. They need to source juices and concentrates from around the world, and blend and package them on an industrial scale. They try to produce the most interesting juice for consumers at the lowest price, by blending perhaps five different juices into one flavour. They need to have the same flavours available year round. They are in essence a packaging, marketing and distribution company. They are focused on business-to-consumer marketing, which means they are involved in television, radio, billboard and internet advertising, product sampling, public relations, and

retailer incentives. The minimum investment is around US\$5 million, because even one Tetra Pak filling line can cost US\$2 million and fills 20 million litres per year. You need this scale to bring down the unit cost and be competitive with soft drinks.

Mixing the two models has a number of issues. First, the investment cost is extremely high. Second, when you use only your own concentrate or juice, the price can vary hugely each year. Also, your sales are now limited by the juice you can produce yourselves. Third, your attention is spread across too many professional areas, which introduces unnecessary risk to companies.

3.5.2 Certification: HACCP and others

Most buyers of purée will as a minimum expect HACCP certification. Additional certification will facilitate marketing of purée to new customers.

3.5.3 Multi-season production

Purée manufacture for export globally or in the region requires professional production. To afford the specialised equipment for production at industrial scale and to be able to invest in skilled staff, the factory needs to operate for much of the year. This is only possible by introducing a variety of products with complementary seasons.

First, fruits with longer production seasons, such as pineapple, can be considered. Other local fruits such as orange can also be included. Global trends also provide some interesting ideas. The vegetable–fruit juice trend could be explored. Some vegetable purées in demand include carrot, cucumber, celery and beetroot. Purées are also in demand in food manufacturing of products such as baby foods, or for frozen or baked foods. These include pumpkin, sweet potato, potato, spinach, mushroom, green beans, courgette and peppers.

The trend of adding herbs and spices suggest even more novel opportunities: ginger and turmeric are examples.

3.5.4 Access to market: find a strategic partner

Processors looking to export product need to consider that the juice market is global and exceptionally competitive. You are most likely trying to convince an importer to replace someone else's product with your product. In the absence of a track record as a supplier of quality product, this is not easy. Why would they drop a well-performing supplier for someone who has not proven themselves?

In other markets you can perhaps convince clients that you have a unique flavour, you can supply at a different time, etc. But juice has a long shelf life, and being different is not necessary an advantage, because it means the flavour of the final product will change. And if you supply something for a new product, the lead time will be long.

This all means that unless you start exporting in a year when the harvest has been bad in India and one or two other key supplying markets, you will struggle. You will need to give heavy discounts of at least US\$100 per tonne to get into the market. Unless of course you have a relationship with an importer, who may have shares in your business or with whom you have signed a long-term sales agreement.

Another challenge a new producer will encounter is cash flow. If you still need to find clients when you start production, you will run out of cash very quickly. Each day in which you work

8 hours you will produce at least a container of juice, worth around €15,000, that probably costs you €10,000. After one month of processing without selling, you will have €300,000 locked up in stock, and will likely be running out of working capital and place to store stock. Furthermore, even if you sell that day, you are not likely to get paid an advance for another 30 days, while payment in full takes another 90 days at least. You will be forced to close down production until you have money, which means your earnings will not be sufficient to pay off the investment loans.

Thus, the best route is to develop strategic partnership with importers (one or more) with whom you can develop your business, and you have guaranteed sales volumes at the start of the season. This partnership would allow you to learn more about the end customer's requirements and to win a space in the global sourcing calendar. It could also help to inform innovation, certification decisions, etc., so that you have an increasingly marketable product.

A second option is to find an experienced distributor or agent and develop your own sales organisation in the end markets. This gives better connectivity to food ingredients companies and lowers the barriers to them sourcing from your company. It is important in this second option to appoint agents who understand the market, have good customer service and who are respected by their peers in the small juice world.

3.5.5 Sound financial planning

Before you start the business, you need to make a detailed cost-price calculations based on the local cost, international benchmarks of processing efficiency, etc. These then need to be compared to world market prices of similar products. Though this sounds logical, most African juice entrepreneurs have never done this kind of calculation. They thus risk building a factory that will never export because their product cannot compete on the international market.

Next, a realistic time frame and financial planning are needed. Construction of a plant will take at least 12 months, so if you are not starting before the mango season, you will not be operational the next season. Furthermore, the first season needs to be planned in as a test season, where limited volumes are produced as the staff learn how to source large volumes of fruit, and ripen and process the fruit. This will require patient capital.

Finally, sound cash flow planning based on realistic assumptions is essential. For example, the payment terms of clients plus one month. It is very common for plants in Africa to run out of cash, which means farmers are not paid. They then stop supplying, and the business eventually shuts down.

3.5.6 Sourcing excellence

A large professional factory needs sufficient volume throughput to make juice production economically viable. This hinges on being able to source enough fruit suitable for juicing. With growing competition in the region this could mean sourcing from neighbouring countries and/or sourcing product from dried mango processors and fresh mango exporters. This is not simple. But companies that can master local and potentially regional sourcing have a distinct advantage.

This could include having your own experienced sourcing managers, extension workers, harvesting teams, transport crates and trucks. The key question there is whether you need to own trucks, or you can rent trucks with drivers to reduce the investment cost.

A good sourcing strategy also includes an understanding of your role or importance to the

farmer. As a juice producer you normally cannot compete with export and premium fresh markets for fruit. You simply cannot afford to pay those prices. So, you need to develop an attractive proposition to farmers that is not price.

There are a number of creative options to develop a good proposition. It could be that you develop a juice grade, and you purchase only those fruits that others cannot use (second and/or third grade fruit). Or you pay an advance or cash on delivery, so farmers sell to you because you solve their cash flow problem. Perhaps you can offer to organise harvesting teams and transport, thereby making the life of the farmer easier. Or you could offer orchard maintenance services.

In any case, sourcing will require dedicated staff who build relationships with farmers and are on the ground throughout the year to estimate the coming crop, and during the season are focused on getting their hands on the mango.

3.5.7 Operational excellence

Good juicing factories rely on experienced factory managers and production staff to introduce and maintain quality, food safety and efficient operations. This allows the factory to respond to unexpected mechanical issues with equipment, carry out planned maintenance and ensure that the equipment is being maintained well.

This team should include skilled maintenance personnel in the company, but also access to suppliers who are able to source parts for repairs or new lines.

3.5.8 Good variety strategies

Most food ingredients companies and juice companies look to create a standard blend. This means that they need to be cautious about introducing new flavours to their product portfolio. This could be either new varieties, or even in accommodating large fluctuations in



flavour. Counterintuitively, introducing a new unfamiliar variety could be problematic. They need to ask whether this would be marketable to their clients. Is the flavour similar to an existing origin or variety? Could they market it to a buyer who is looking for a special edition flavour? Or would this just add complexity?

3.6 Issues and opportunities summary

Table 2. Issues and opportunities

Issues	Opportunities
<ul style="list-style-type: none"> ▪ Declining juice market ▪ Highly competitive market with relatively few buyers ▪ Global sourcing ensures that smaller suppliers compete with large companies in major sourcing origins ▪ High cost of mangoes in Africa linked to smaller production and competition from fresh exporters and dried mango processors ▪ The market demands quality production that necessitates highly technical production – success hinges on operational excellence at each stage of production ▪ Economies of scale matter, but this requires sound economic planning, good sourcing and excellent operations ▪ Unfamiliar varieties struggle to get a space in the global sourcing calendar 	<ul style="list-style-type: none"> ▪ Processors with multi-season, multi-product systems are most likely to succeed – growth in vegetable purées might offer opportunities ▪ Increasingly innovative market, which could be open to new specifications with the right degree of preparatory work (e.g. demonstrating the flavour, Brix) ▪ Opportunities for differentiation – organic, product range (vegetable and fruit), seasons, sustainability, etc. ▪ Regional buyers source purées on the global market – could they offer a market nearby?

SECTOR STUDY: PROCESSED MANGO

1. Fresh cut mango
2. Dried mango
3. **Mango puree**
4. IQF mango
5. Mango pickle
6. Mango vinegar
7. Mango butter
8. Mango briquettes
9. Mango based compost



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