

# Drying Local Orchard Fruits

A Feasibility Study

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Report prepared by



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## Introduction

The previous work looking into the economic feasibility of local orchard fruits identified a crop with particular characteristics. There is no shortage of fruit trees growing in Powys. However, with the absence of large scale commercial growers, the trees tend to be widely scattered. The resurgence of interest in apples particularly sees many of the younger trees being planted in gardens or smallholdings. Many others, particularly the older individuals, are found on farms or in the grounds of the larger houses and estates. The majority of these trees, particularly the older ones, could be said to be un or under-managed, and as a consequence generally speaking the crop of fruit from these trees is of a poorer or at the very least highly variable quality. There is a wide range of varieties found in Powys, particularly on younger trees that are planted by enthusiasts. The size and scattered, poorer nature of the crop makes it very hard to find an economically useful outlet for its owners, consequently where the crop is not being used by the owner the fruit is usually left on the tree.

I am interested in exploring the possibility of using this under used, locally available, and rather variable crop in a way that would make it easier to store and transport. I am committed to producing any product in as sustainable a way as possible. The process of drying the fruit therefore seemed to provide lots of potential. What follows is an account of how I explored the idea of sourcing, processing and marketing dried single varieties of apples, without the use of additives, found growing close to Presteigne on un or under-managed trees.

## The Process

### The Crop (characteristics etc..)

The crop was found extremely easily. Several growers who had responded to the earlier economic feasibility study were contacted and small ads in local shop windows, an article in local parish magazines and word of mouth gave me access to a wide variety of fruit. All of this fruit was excess to the growers needs and a surprisingly high amount of it was of very good quality. The majority of it was sourced locally to Presteigne within approximately 5 or 6 miles of the storeroom. Most of the fruit was visited at least once or twice to check for ripeness before it was picked. The following table details the varieties sourced:

Variety		Variety	
Adams's Pearmain	Dessert	James Grieve	Dual
Arthur Turner	Cooker	Kings Acre Bountiful	Cooker
Ashmeads Kernel	Dessert	Monarch	Cooker
Blenheim Orange	Dessert	Newtown Wonder	Cooker
Bramley	Cooker	Norfolk Beefing	Dual
Cornish Gilliflower	Dessert	Norfolk Royal	Dessert
Crimson Quoining	Dessert	Pitmaston Pineapple	Dessert
Devonshire Quarrenden	Dessert	Scotch Bridget	Cooker
Discovery	Dessert	Tom Putt	Cooker/Cider
George Cave	Dessert	Twenty Ounce	Dual
Hambledon Deux Ans	Dessert	Worcester Pearmain	Dessert
Herefordshire Beefing	Cooker	Yellow Ingestrie	Dessert
Howgate Wonder	Cooker		

## **Storage**

Once picked the crop was taken back to a store room. I was keen to explore what the storage capabilities of the crop were without the use of carbon expensive refrigeration systems. The approach utilises a UV light to reduce the impact of flies. A daylight and insect screen has been placed over the window which keeps the room dark throughout the day and prevents most flying insects from entering. This allows the window to remain open at all times which has kept the ambient temperature of the room well below normal room temperature. This has resulted in the crop storing surprisingly well with some varieties, particularly Adams's Pearmain, Ashmead's Kernel, Bramley, Hereford Beefing and Hambledon Deux Ans lasting in a state that would enable them to be eaten well into April. The fruit is kept in clearly labelled boxes and crates, that records the variety, date of picking, weight and location. The boxes are inspected regularly to remove any that are deteriorating.

## **Processing**

The crop is selected for drying in separate batches according to the variety and its likely storage properties (ie those varieties that store less well are used first). Selected from the boxes by hand they are rinsed under running water before being taken into the drying room. Here they are processed using a hand operated corer and slicer before being laid out on the drying trays and inserted into the drier.

## **Additives**

For the purposes of these trials a number of additives have been applied to the fruit to assess the benefits that they bring to the end product. These, and the conclusions that I have come to are described below:

Preservatives: the process of drying itself obviously extends the shelf life of the fruit. This is done by removing moisture which is one of the most important requirements for pathological bacteria. My interest in producing a natural product was paramount over the use of preservatives unless they brought about specific benefits to the appearance and presentation of the finished product. Again however I was reluctant to use a preservative if there was any concern over the preservatives health implications even if it produced tangible benefits. Ascorbic, Citric, Malic and Tartaric Acids were applied to the fruit. The preservative properties of the different acids arise from the fact that by increasing the acidity on the surface of the product an inhospitable environment for bacteria is created. In a naturally acidic product that has also had another key requirement for bacteria, moisture, removed their usefulness is obviously going to be limited. I tested granules of the above acids in accordance with the guidelines provided by their suppliers. This involved dissolving different amounts of the granules in water and then immersing the sliced fruit in a bath of this solution for a determined period of time. For results see the 'Testing' section below.

## Flavourings

Lemon Juice & Honey: taken from fresh fruit and sourced locally respectively, different concentrations were applied to the sliced fruit by adding it to water and immersing the fruit in a bath for different time periods.

## **Drying**

This was done using an American sourced commercial dehydrator. This provides flexibility with different drying temperatures and when coupled with a plug in timeswitch, automatic control over the length of drying time as well. The fruit was dried under different regimes which included varying times and temperatures and, with some fruits, thickness of slices. (See Testing section below for results)

## Testing

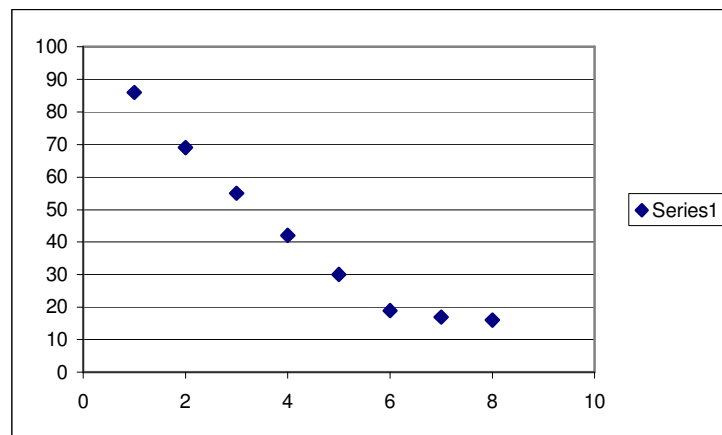
### Drying

In determining the optimum time and temperature to dry the fruit a balance needs to be struck between the quality of the end product and the cost (in terms of time and carbon) required to dry the fruit. According to most literature the fruit needs to be dried to the point where it represents between 10 and 20% of its fresh or 'wet' weight. There is obviously going to be high degrees of variation in the properties of the fruit, not least in the varieties themselves but moisture levels, ripeness (ratios of sugars and acids etc) and size will also play a part in effecting the results. Using a slicing machine however enabled at least a uniform thickness of slice to be produced, which removed this variable from the equation.

Before the fruit was placed into the drier it was first of all weighed using a digital scale. The drying start time and wet weight of each tray was then recorded on a form and the fruit left in the drier for differing amounts of time and temperatures to assess the most effective means of arriving at the required degree of dehydration.

Results: the relationship between time and temperature is a close one. Less time at a higher temperature might produce a similar result to more time at a lower temperature.

- a. Less than 6hrs at 57°C and the fruit is not dry enough to prevent decay, ie the end product is too moist and succumbs to mould and fungal attack after about 3 weeks in some cases, even in sealed bags.
- b. Longer than 6hrs at 57°C and a curious result occurs. The fruit continues to desiccate but at a much slower rate. Whereas the first two hours sees a weight loss of 30%, (at a rate which continues more or less unchecked for the following 4 hours), the two hours after the 6<sup>th</sup> sees a reduction of just 3% (see table below).



In fact by approximately 8 hours there is often no longer any change in the weight of the end product but the other properties continue to change, particularly the feel and texture of the slice. After this length of time the fruit becomes crispier, often snapping and tasting much rougher, even though it is not getting physically any drier.

- c. Lower than 57°C at 6hrs sees the same result as a. above (ie too much moisture left)
- d. Higher than 57°C at 6hrs and the taste is altered detrimentally, presumably from a

caramelising or actual cooking of the sugars present. The end result tastes more of a cooked apple than a fresh one.

Conclusion: The experiments that I conducted revealed the optimum time for drying the apple rings to be approximately 6 hours and at a temperature of about 57°C.

## **Additives**

### Preservatives

Because of my interest in producing a natural product I am only interested in pursuing the use of preservatives if they bring about significant benefits over the shelf life of the natural, unadulterated version. I therefore took as the baseline the natural dried fruits longevity (shelf life), and sought to test Ascorbic, Citric, Malic and Tartaric Acids against this to see how they performed.: Two different varieties of apple were tested in varying concentrations of the above substances.

### Flavourings

In the event that the natural, unadulterated dried fruit did not perform well enough in taste tests I sought to establish whether Lemon Juice and Honey might enhance the taste of the end product.

### Conclusions

None of the four acids made any detectable difference to the short term longevity of the product. This was tested by myself using organoleptic tests over different time periods. Long term Shelf life of the natural version was established by the Public Health Laboratory in Hereford (see below). The 2 Flavourings produced variable results which are discussed more fully in the Organoleptic section below. In light of the extremely good results emerging from the Public Health Laboratory relating to the natural, unadulterated version there seems to be no clear reason why preservatives should be applied to the fruit.

## **Shelf Life**

Having established an optimum drying time and temperature and established that artificial preservatives provide no advantage a batch of dried fruit, consisting of fruit taken from the one tree and picked at the same time, was submitted to Hereford Hospital Public Health Laboratory for an accredited shelf life analysis. This batch was 'natural' ie without any of the preservatives or flavourings listed above. The analysis includes 6 tests for: Salmonella, E. coli, Yeasts, Moulds, Listeria monocytogenes and Staphylococcus aureus. The batch was tested upon submission and again at monthly intervals.

Results: So far, after 6 months the results are as follows:

Salmonella: tested upon submission and found to be not present in 25gm of sample.

E. Coli: tested upon submission and monthly afterwards and on all occasions found to be below 20cfu/gm (cfu = colony forming unit).

Yeasts: tested upon submission and found to possess 20cfu/gm and subsequently monthly and found to possess less than 10cfu/gm on every occasion.

Moulds: tested upon submission and monthly afterwards and each batch has varied between 10 and 30cfu/gm.

Listeria: tested monthly and found to possess less than 20cfu/gm on every occasion.

Staphylococcus: tested upon submission and monthly afterwards and found to possess less than 20cfu/gm on every occasion.

Conclusion: These results are considered satisfactory for all parameters tested and consequently determine that, from a microbiological point of view, the product has a shelf life of **at least** 6 months and without any additional preservatives being added to it. Organoleptic tests, for taste and appearance in particular, may therefore be more important in determining the actual shelf life from a customers point of view (see below)

### **Nutritional Analysis**

Most of the literature that I have consulted or been provided with state typical figures for the nutritional analysis of dried fruit with their skins removed. Because of the need to maintain the character of the single varieties of fruit by keeping the skins on I was keen to establish what difference this might make to the nutritional properties of the fruit. Consequently a batch of dried Adams Pearmain was submitted to Alcontrol Laboratories for a Group 2 Nutritional Analysis.

Results: The results obtained (column A) are here compared against two other published samples obtained from McCance and Widdowson\*. Column B carries the average results from 15 varieties of raw fresh apple and column C refers to raw and peeled fresh Bramley:

<b>Test Description</b>	<b>Column A</b>	<b>Column B</b>	<b>Column C</b>	<b>Units</b>
Energy	1447	199	151	Kj
Energy	341	47	35	Kcal
Moisture (Oven Dry)	10.0	84.5	87.7	g/100g
Protein (N x 6.25)	0.9	0.4	0.3	g/100g
Ash	0.9	N/a	N/a	g/100g
Total Fat	0.6	0.1	0.1	g/100g
Dietary Fibre (AOAC)	4.7	1.8	1.6	g/100g
Total Carbohydrate (by difference)	87.6	11.8	8.9	g/100g
Available Carbohydrate (by difference)	82.9	N/a	N/a	g/100g
Sugar	46.4	11.8	8.9	g/100g
Saturated Fat	55.1	Trace	Trace	% of fat
Mono-unsaturated Fat	10.6	Trace	Trace	% of fat
Poy-unsaturated Fat	30.0	0.1	0.1	% of fat
Trans-unsaturated Fat	<0.1			% of fat
Sodium	0.01			g/100g
Sodium Expressed as Salt	<0.1			g/100g

Conclusions: for all the components that I have figures to compare with there is a dramatic increase in the different substances found in the dried fruit. Presumably this is because they are being concentrated, when expressed as a proportion of 100gms, during the drying process. The majority of the weight of the fruit lies within the moisture it contains so as this is driven away the other components are concentrated. It needs to be borne in mind however that my results relate to just one variety and, whilst these figures seem very interesting, another variety submitted to the same test may perform much worse. Nevertheless, it seems clear that the properties of the dried fruit are enhanced, possibly considerably (in some instances here by as much as almost 10 times) when compared to the fresh fruit. The dried seems to possess particularly high amounts of energy, carbohydrate and sugar which does suggest a potential market within the active sports community, particularly where weight saving is necessary for walkers or mountain bikers.

## **Vitamin C**

Being sensitive to heat it can be assumed that the Vitamin C content of the dried fruit will be negligible. I sought to establish how far the denaturing of the vitamin went when subjected to the gentle heating of the drying process. I submitted two samples to Reading Scientific Services Limited of the same fruit, again taken from the same tree at the same time. One sample was of fresh apple and the other dried.

Results: despite my initial assumptions the results were surprising. The fresh fruit yielded 29.1mg of vitamin C per 100g, whereas the dried yielded no less than 60.9mg/100g. This means that the Vitamin C does indeed denature and by approximately 65%. However due to the fact that, because the moisture and weight is being driven off, you are getting more apple per mass of product you are ending up with a nett gain in the Vitamin C content.

Conclusions: The very high concentration of Vitamin C found in the dried product supports the fact that the drying process is gentle enough to preserve adequate quantities of Vitamin C to the extent that a 100g serving provides just over 100% of the RDA (Recommended Daily Allowance) of Vitamin C for adults and children alike

## **Organoleptic Tests**

### **Appearance:**

Like any fruit exposed to air a browning of the flesh occurs. I wanted to test to see whether any of the additives listed above reduced this browning and improved the appearance of the final product.

Results: Of the Ascorbic, Citric, Malic and Tartaric Acids the latter two provided no reduction whereas the Ascorbic and Citric acids reduced the browning marginally but at a concentration that effected the taste detrimentally (see below). Likewise the Lemon Juice, although the effect on the taste was less unpleasant, the prevention of browning seemed more sporadic with less uniform results.

Left with the natural, unpreserved slice I needed to see what difference daylight would have on the product. Using the same batch placed in plastic bags, one sample was placed on a windowsill whilst the other placed inside a cardboard box. The changes that occurred in the light sample took place over a very long period of time, with only a very gradual orangening taking place. After 7 months of exposure to daylight the product looked significantly different to the dark pack.

### **Feel:**

The organoleptic tests of the feel of the dried apple did not reveal anything of any significance. The different preservatives applied to the fruit did not seem to make any difference to how it felt.

### **Smell:**

The organoleptic tests of the smell of the dried apple did not reveal anything of any significance,

### **Taste:**

A total of 7 different treatments were tested for their effects upon the taste of the finished product:

Natural: Without any additives the apples seem to display a common pattern of taste development. For the first 5 to 10 seconds in the mouth the apples feel dry and tasteless. This

is as one might expect; The drying having driven off the moisture to leave concentrated forms of fruit sugars and acids, locked inside the dry and inert surface. However, once the moisture within the mouth is allowed to soak into the fruit, through the surface, these substances are quite vividly resurrected to reproduce an intense apple flavour that continues for quite some time. This is presumably because continued chewing brings more of the acids and sugars into contact with the moisture and prolongs the flavour.

Ascorbic Acid: At concentrations that made a significant impact upon the appearance of the product the Citric Acid created a slightly unpleasant pretaste upon first putting the fruit into the mouth. This bitterness tended to dominate the natural flavours of the apple variety itself.

Citric Acid: At concentrations that made a significant impact upon the appearance of the product the Citric Acid created a slightly unpleasant pretaste upon first putting the fruit into the mouth. This bitterness tended to dominate the natural flavours of the apple variety itself.

Malic Acid: This did not seem to make any kind of difference to the taste of the apple except at very high concentrations whereupon a bitterness was revealed.

Tartaric Acid: this produced the most unpleasant taste of all the additives tried. Even at quite low concentrations there existed a dry bitterness that was most unsatisfactory.

Lemon Juice: This seemed to enhance very slightly the tanginess of the dried apple, particularly upon first putting it into the mouth. Not unpleasant it tended to continue during eating

Honey: This seems to almost deaden the flavour of the original apple. It adds a sweetness to the initial dryness upon first putting it into the mouth and tastes marginally sweeter throughout tasting, but for some reason there seems to be no release of apple flavour once the moisture is replaced and the apple broken down.

Conclusions: The commercially produced Acids failed to prevent the oxidising without effecting the taste. The lemon juice may have been workable were it not for the fact that the subtle differences in taste that arise from the different varieties were masked or altered by the lemon juice and it did not provide consistent results. The natural apple slice remains the best and most consistent product in terms of taste even though its initial appearance may act against it from a customer's point of view.

The light test demonstrated that were the product to be packaged in a clear plastic bag its realistic shelf life would need to be less than 7 months.

## **The Product**

Having conducted a wide range of tests I have ended up with a product that displays the following qualities or optimum characteristics:

1. Dried to the point where it is at approximately 10 to 20% of its original weight;
2. Dried with no preservatives added, in light of the end product's more than adequate performance in the microbiological shelf life test;
3. Dried with no flavourings added, in light of those tested failing to perform better than the 'unflavoured' version;
4. It is virtually inert when stored in a cool and dark, airtight place;
5. When exposed to air it takes a long time to rehydrate and does not readily deteriorate (this has not been possible to quantify to date);
6. When exposed to light it takes at least approximately 4 months to discolour significantly

7. Because of the inadequacies of the preservatives and flavourings I am left with a product that is capable of demonstrating the subtle differences in flavour that exist in individual varieties of apple;
8. The visual characteristics of the individual varieties are further enhanced when they are dried with their skins intact;
9. Because of the method of drying the product has an extremely good capability to provide very high levels of energy (when expressed as KJ);
10. Because of the method of drying the product has an extremely good capability to provide very high levels of carbohydrates (when expressed as g/100gms);
11. Because of the method of drying the product has an extremely good capability to provide a very high percentage of both the adult and childrens RDA for vitamin C (when expressed as mg/100gms);

It is a light, non messy, non bulky, durable snack with excellent shelf life, providing an extremely healthy alternative (in terms of energy, carbohydrates and Vitamin C) to most other snacks on the market. I have not found any other gourmet snack with the same profile in terms of its physical, environmental and health characteristics

## Marketing

### Markets

In light of the properties described above I am currently making preliminary explorations to establish the potential interest in the product from the following markets:

Landscape Tourists; visitors to the Marches who are interested in its landscape and heritage, typified perhaps by Offa's Dyke walkers or National Trust Members. They are more likely to be interested in the varieties and their history, where the apple was sourced from and the nutritional qualities provided while they are walking. The convenience of the snack will also be important. I have placed a display stand with a range of different varieties packaged in 20gm bags in both the Offa's Dyke Centre, Knighton and the Judges Lodgings, Presteigne. Negotiations for a similar trial are currently ongoing with the National Trust at Croft Castle, Leominster.

'Foodies'; customers who are interested in good quality or unusual foods. They are more likely to be interested in the product's novelty value, the uniqueness inherent in the single varieties and their different taste and appearance as well as the provenance of the variety and the fruit itself. I have sold numbers of the 20g bags on three occasions at Presteigne Farmers Market. 14 20g bags priced at £1.50 each were sold at the October and November markets and 16 20g bags were sold at the December market, opportunities that garnered some very positive feedback from the customers on each occasion. I hope to set up a trial with a delicatessen in Ludlow and at Borough Farmers Market in London. Clarkes in London and the Left Bank Deli in Hereford have both declined the offer of a trial. No reason was given by Clarkes and the Left Bank explained that they didn't think it would be of interest to their customers.

Active Sports Enthusiasts; customers who are in need of a high energy snack in a light, compact and non-messy form. They are Typified perhaps by Mountain Bikers or other extreme sports activists. Mountain Bike shops in Machynlleth and Builth Wells have been contacted but were not able to provide space for a trial. A Mountain Bike shop in Rhayader is interested in accommodating a trial, and a questionnaire to accompany this is currently being prepared.

Schoolchildren; responding to the interest and demand for healthy snack alternatives from both parents and schools, a number of trials have been undertaken in 4 different schools, involving age groups 7 to 11. I have carried out 17 different tests in the 4 schools, with many of the tests

repeated to provide a bigger sample size, in order to see if the pupils expressed any preference between cookers and dessert apples, green or red skinned, natural or honeyed, chewy or crispy etc. Their results have produced over 4400 different units of data and this information is still being processed, but the following breakdown is available:

Schools	date	boys	girls	7yrs	8yrs	9yrs	10yrs	11yrs	totals
Franksbridge	28/03/07	7	6	0	0	0	8	5	13
Clyro	19/04/07	11	14	0	0	8	7	10	25
Presteigne	26/04/07	17	12	7	21	1	0	0	29
Llandrindod Cefnlllys	14/05/07	25	16	0	14	7	15	5	41
<b>Totals</b>		60	48	7	35	16	30	20	108

### **Packaging**

Due to the fact that there is a degree of photosensitivity (albeit over a long term) it would be sensible to consider displaying and selling the product in a light-proof package. Paper packaging would not act as an adequate moisture or microbiological barrier and so would seriously limit its shelf life. A combination package of paper plus plastic may work unless a light-proof plastic material can be found. Biodegradability of the packaging would also add to the environmental credentials of the product.

### **Presentation**

Would need to reflect the needs of the different markets (see above). The four categories described above would potentially need at least two, possibly three, different designs in order to appeal to their audience. The landscape tourist and foodie may be attracted to a similar design (perhaps appealing to the ideas of tradition and history and culture), but this would need to be wholly different to catch the eye of a younger, more active clientele such as mountain bikers or schoolchildren (who might look for something that is more contemporary in its appearance). Schoolchildren themselves might need different presentation on account of their needing smaller portions in a bag

### **Pricing**

The product is extremely labour intensive. Starting with the locating and checking of the crop, selecting, harvesting, transporting, storing, processing and packaging, every aspect relies on care and attention. Because of this and the obvious need to recover the other overheads involved (electricity, consumables etc) the product will need to be placed in the higher priced end of the market, which may also have a bearing on the packaging and presentation

### **Where next**

Further, more detailed, work on the above marketing issues will be carried out over the summer with the help of Business Advisors and Design Wales. This will be done in an attempt to enable me to begin selling on a commercial scale by the end of the autumn 2007.