SPRAY DRYING TECHNOLOGY FOR PRODUCING FRUIT POWDERS FROM TOMATOES AND TOMARILLO

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Abstract: A Post harvest loss in tomato is a major problem in the market supply chain of small farm holders in India. Spray drying is one of the effective post harvest technology used for making fruit powders of long shelf life. The spray drying behaviour of different tomato varieties and tomarillo was studied with continuous observation of parameters like feed flow rate, setting of inlet and outlet temperature and addition of malt dextrin using a commercial scale spray drier located in Gandhigram trust under a public-private-partnership mode study in link with Aruna agro agencies Ltd. Theni. Tomato collected from growers of oddanchatram (Indam-Ruchi), Dindigul (Co-3) and Theni (PKM-1) and Tomarillo (Red) and (Yellow) from Kodaikanal growers were used. With the feed rate of 80ml per minute in to the atomizer, addition of 40gm malt dextrin in 1 lit pulp, controlled by the peristaltic pump, inlet air temperatures of 160^{o}C for tomato and 164^{o}C for tomarillo at a constant outlet temp of 90^{o}C were observed as the optimum conditions for the maximum recovery of tomato and tomarillo fruit powders.

Key words: spray drying; tomato powder; tomarillo powder; optimum temperature.

Introduction:

Tomato (*Solanum lycopersicum* L.) is the largest produced and consumed vegetable crop in the world. Tomatoes are well known as a health promoter having vitamins and disease fighting phyto chemicals especially lycopene. Tomatoes are top source of Vitamin A and C, contains more dietary fibre, beta-carotene, iron, lycopene, magnesium, niacin, potassium, phosphorus, riboflavin and thiamine. Tomatoes are low in saturated fat, cholesterol and sodium. (**Charanjeet *et al* 2004**)

Tomarillo (*Solanum betaceum* Cav. *)* belong to the same family, solanaceae and is a subtropical fruit tree called “night shade plant” bearing egg shaped fruits. Tomarillo fruits have a bright future because of its flexible uses and the long production season (***Prohens and Nuez 2000).*** These fruits are acidic, known for good source of provitamin A, vitamin C, B6 and E, and iron

India ranks first in the world production of fruits and second in vegetables, accounting roughly 10 and 15 per cent, respectively, of total global production. India ranks 6th in the world Tomato production (FAO). The National policy aims to increase the percentage of food being processed in the country to 25 per cent by 2025 (MOFPI). Food processing adds value, enhances shelf life of the perishable farm produce and encourages crop diversification.

In Tamil Nadu tomato crop is cultivated in more than 28,000 Ha with average production of 3.25 thousand tonnes per year. Tomato is the major vegetable crop cultivated in Dindigl district of Tamil Nadu on an area more than 2200 Ha across 5 major taluks with a tremendous potential of post harvest processing. Tomarillo is

cultivated in hilly regions of west Bengal, Maharashtra, North eastern states. Tomarillo or tree tomato usually start bearing fruits from 1.5- 2years and will give fruits for more than 10 years.In Tamil Nadu, mainly grown in Ootachamund and Kodaikanal.

Farmers are getting very low returns with loads of marketable surplus during Rabi season (Feb-June), Rs.2-Rs.5/kg (0.05 to 0.1US$) for tomato and for tomarillos, Rs.10-12 (0.2-0.25 US$). Tomato/ Tomarillo powder holds potential market for processing industries in making sauce, ketchup, chutneys, soups and baby foods.Unlike most foods, cooking or processing of tomato (e.g. tomato paste, powder, soup, tomato sauce) is beneficial to health. This is due to the fact that heat breaks down the cell walls, increasing the available lycopene content.

Drying is the cheapest mode of preservation of fruits and vegetables. Dehydrated Tomato powder holds a promising and potential market for processing industries for preparation of products like sauce, ketchup, chutneys, soups and baby foods. Tomato powders are ready to use in vegetable and curry mix, reduce the bulk for storage, transport and packaging with extended storage life. Tomato and tomato products are the major sources of lycopene and are considered to be important contributors of carotenoids in human diet (**Tapiero et al. 2004; Goula and Adamopoulos 2005**). There are few tomato processing units available in India as well as in Tamil Nadu with a potential market for dried fruit powder. While many of the research studies are restricted only with laboratory scale dryers (eg. Buccini), the present study was conducted using the pilot scale commercial drier (ACMEFIL) of Gandhigram trust, in partnership with Private industrial partner in Theni (Aruna Agro Agencies Ltd.).

Spray-drying is defined as the transformation of liquid state feed into a dried particulate form. This is achieved by atomizing the fluid into a drying chamber, where the liquid droplets are passed through a hot-air stream (**Masters, 1991**). It also provides the advantage of weight and volume reduction. Parameters like concentration of juice, addends, feed flow rate and also the inlet / outlet air temperatures have a significant role in the yield of Fruit powders. Fruit powder is hygroscopic and requires drying agents such as starch, Arabic gum and malt dextrin for making spray dried powders (**Jaya and Das, 2004**). **Gupta** used liquid glucose as addend to produce free flow orange fruit powder. **Bhandari *et al 2008***, found that wettability of fruit powder with lower inlet air temperature was better than higher inlet air temperature. The optimum conditions like feed flow rate of 15ml/minute; inlet air temperature of 130^0C and outlet air temperature of 85^0C have been obtained using liquid glucose as addend for recovery of Orange fruit Juice powder (**Chegini and Ghobadian, 2007**).

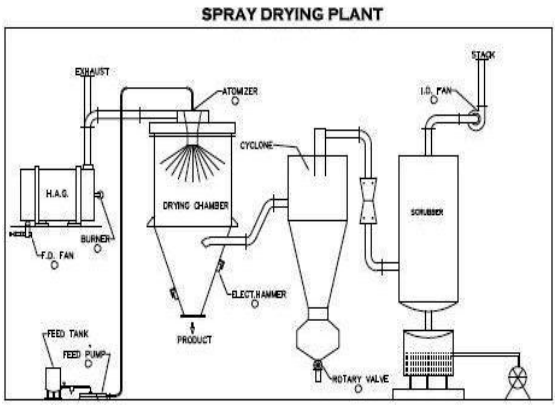
The objective of this study involves determining optimum parameters for spray drying using fresh juice extract of tomato and tomarillo with 8% malt dextrin as an addend.

Materials and Methods:

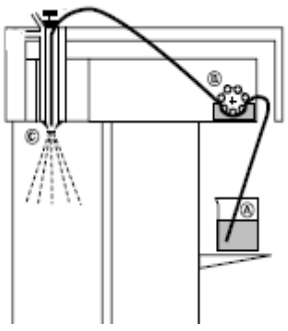
Materials: Hand-picked, ripe tomatoes collected from growers of Oddan-chatram (IndAm-Ruchi), Dindigul (Co-3) and Theni (PKM-1) and Tomarillo (Red) and (Yellow) from Ooty and Kodaikanal growers were used. Fruit pulp extracted using a power operated Fruit Pulper (Advance Machineries, cbe). The aqueous extract was then

filtered ensuring removal of skin and seeds. Dextrin (Commercial grade) supplied by Udhayam Scientific Company @Rs.30/kg was used at the rate of 8 gm/ litre of pulp used. Filter cloth of 100mesh, clean RO water were used.

Spray Equipment: The drying was carried out in an ACMEFIL make spray drier (5 kg output capacity/hour) available with DST Post Harvest Centre, Gandhigram Trust, located in Dindigul district of Tamil Nadu.



The main components of the drier were the feed system, air compressor with blower, rotary disk atomizer, cyclone and peristaltic pump. The feed system of drying air constituted of a blower and an air filter. The inlet and outlet air temperature were controlled, manually adjusted and the product was collected in a cyclone.

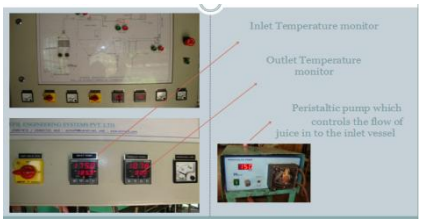


A. Filtered pulp

B. Peristaltic pump which regulates pulp feed flow rate.

C. Atomizer nozzle spraying conc. juice in to the drying chamber.

Inlet/ outlet air temperature control Panel:



Methodology:

The process steps comprise:

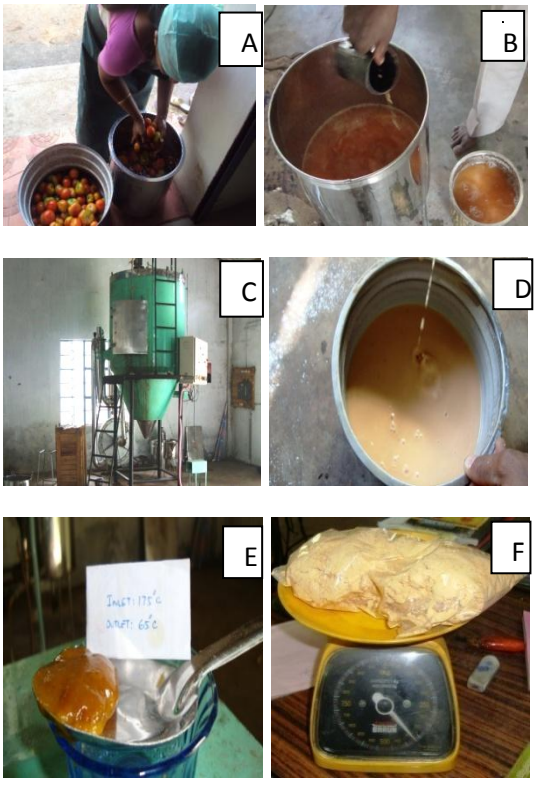
(a) Pre treating fruits for 3 minutes in Hot water 60^{o}C & blanching.
(b) Collecting fruit pulp & filtering.

(c) Addition of water soluble drying aid – Malt dextrin.(40gm/ lit of pulp)

(d) Controlled flow of juice in to the atomizer (pump setting 80ml /min).

(e) Controlled inlet and outlet air temperature of the spray dryer.

(e) Collection of powder from the cyclone and bottom outlet



A. Tomatoes washed, pasteurized & Juice collected
B. Tomato/ Tomarillo Juice get filtered
C. Pilot scale Spray drier (Acmefil make) – GGM.
D. Malt dextrin was added slowly and stirred well
E. Tomato paste obtained with inlet temp of 170^{0}C
F. Fine powder obtained at an inlet temp of 160^{0}C

Tomarillo and Tomato powders

1. ***Tomarillo powder at 170^{0}C* – sticky**
2. ***Tomarillo powder at 164^{0}C* – fine powder**
3. ***Tomato powder at 165^{0}C* – caking**
4. ***Tomato powder at 160^{0}C* – fine powder**

Process Flow Diagram

Washing
↓
Pulping
↓
Filtering fibre
↓
Adding Malt dextrin (8%)
↓
Feed Rate (80ml/min) Peristaltic pump
↓
*Set Inlet temp and Outlet temp (*90^{0}C)
↓
Atomization and Spray
↓
Powder collected from the cyclone

For complete recovery of fruit powder, various combinations of processing parameters were studied. The feed flow rate was regulated @ 80ml/minute with varying Inlet temperatures at 180^{0}C; 170^{0}C; 160^{0}C for tomato and 184^{0}C; 174^{0}C; 164^{0}C for tomarillo with constant set outer temperature of 90^{0}C

Results and discussions:

Pulp extracted from three tomato varieties were used for the study. Batch size of 2 litres of pulp used for each experiment, keeping the feed flow rate of 80ml/minute, varying inlet temperature till full powder recovery and set outlet temperature of 90^{0}C.

Table 1: Results with Tomato pulp (pkm 1) 1 lit + 8gm malt dextrin

B. N	Inlet Temp ^{0}C	Outlet Temp ^{0}C	Feed flow rate (ml/min)	Results
1	180	90	80	Sticky conc.
2	170	90	80	Paste
3	160	90	80	powder

Table2: Powder recovery from 3 tomato varieties

Var	*TSS*	*pH*	*Acidity*	Outlet Temp ^{0}C	*Inlet Temp ^{0}C*
PKM1	*6*	*4.1*	*0.4*	90	*160*
Co-3	*5.6*	*4.9*	*0.38*	90	*160*
Ruchi	*5.27*	*4.5*	*0.36*	90	*161*

Table 3: Tomarillo pulp 1 lit + 40 gm malt dextrin (tomarillo pulp + water 1:2 ratio)

S,no	Inlet Temp ^{0}C	Outlet Temp ^{0}C	Feed flow rate (ml/min)	Results
1	184	90	80	paste
2	174	90	80	flakes
3	164	90	80	powder

Table 4: Inlet temp. For complete powder recovery of Red and Yellow Tomarillo

Var	*TSS*	*pH*	Outlet Temp ^{0}C	*Inlet Temp ^{0}C*
Red	*9.8*	*3.9*	90	*164*
Yellow	*9.8*	*3.88*	90	*164*

Discussion:

With 40gm addition of malt dextrin in 1 litre of fresh pulp and with a feed flow rate of 80ml/minute; an inlet air temperature of 160^{0}C for tomato and 164^{0}C for tomarillo with an outlet temperature of 90^{0}C were observed as the optimum conditions for the complete recovery of fruit powder.

Yield:

10 litres of pulp yield 1kg of tomato / tomarillo powder.

Reconstitution:

Clean tangy tomato/ tomarillo juice obtained by addition of 5 parts of water with one part of powder.

Future Research:

-Analysing Physical, Chemical and biological properties of Tomato and Tomarillo spray dried powders

-Finding out suitable, commercial scale, cheaper method of lycopene extraction from tomato/ tomarillo skin, powder (using solid-liquid extractor which was used for commercial flower concrete extractor, for example).

-comparative and correlation study of spray dried powder obtained from different tomato and Tomarillo varieties -sensory evaluation of food recipes made out of tomato/ tomarillo powders.

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