

Freezing of fruits and vegetables

An agribusiness alternative
for rural and semi-rural areas

by

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I	a	a	W
	a	W	a
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I F	I		a
L	L		a
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ca fr	F		a
ra -	F		a
	F		a
a r c	F		a
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	F		a
r a r r f	F		a
	F		a
c a	F		a
	F		a
	()	W	a
	W	a	W
	W	a	a
	W	a	a
	W	a	a
	W	a	a
da	A	a	a
	A	a	a
	A	a	a
r fr	A	a	a
a	A	a	a
	A	a	a
r ra	A	a	a
	A	a	a
r ar	A	a	a
ac a	A	a	a
	A	a	a
c fr	A	a	a
	A	a	a
S c	A	a	a
dar	A	a	a
ac a	A	a	a

S a c f r r

M l g w l
a l g a a a a
w a w l
g a g a a l a

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- e a d	34
B a e	34
a e a	36

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- rr a ffr f d d r - S a d r c r

I a a g a l l a
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a l E l a a l \$ 27.3 S 2001 a a \$
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l a \$ a l 11.1 13 \$ a 2000
(Q F F l I a a , 2000). a 1 l
l l a a a 2001.

A d a a ffr c d c r

D l , a l S , l a a a a l a l
g a . \$ a l S a
7 \$, 01. S

a a a
 a a a
 a a a

W a l l a s t e a n d e n v i r o n m e n t a l i m p a c t s a n d h e a l t h e f f e c t s o f a i r p o l l u t i o n . S i n c e a i r p o l l u t i o n i s a g l o b a l p r o b l e m , a n i n t e r n a t i o n a l a p p r o a c h i s n e e d e d . G e n e r a l l y , a i r p o l l u t i o n i s c o n s i d e r e d a s a l o c a l p r o b l e m . (E n v i r o n m e n t a l A g e n c y , 1 9 7 7) .

P a r t i c u l a r m a t t e r s a n d a c i d r a i n a n d a i r p o l l u t i o n a n d h e a l t h e f f e c t s a n d a i r p o l l u t i o n a n d h e a l t h e f f e c t s . I n a d d i t i o n , a i r p o l l u t i o n a n d h e a l t h e f f e c t s . P a r t i c u l a r m a t t e r s a n d a c i d r a i n a n d a i r p o l l u t i o n a n d h e a l t h e f f e c t s . A n d a i r p o l l u t i o n a n d h e a l t h e f f e c t s .

la a a g l a l l a a l a l a
l a a l a l a g l
a g w g a l g a g l a a
a a l l . I a a l
l , a w a a a a l a
l w wa l g w (D a l
, 1977).

1.2 e e e e s e ee e ss

F g a w l l l a a l a a l a g l
l a a l a . B g g w a
, a a w a g a

Wa l l a a a l l a a l - a a l
 a l l a l a .
 l l l l l 1928 l l l -
 a a a l l Ca B l . A
 l l a l , a l l a l , a
 Wa a l l a l l a l l l l l
 a l l l l l l l l l l l l l l l
 Wa a l l a l l a a l l a a l l a a l l - a l l l l a l l
 l l a . F , - l l l - a a l l l

அ... அ... (P... L... , 1993).
 அ... அ...
 அ... அ... F...
 அ... (P... L... , 1993).

F...
 அ... அ...
 அ... S...
 அ...
 அ... F...
 அ...
 (அ...) அ...
 அ... (1986)
 அ... (P... L... , 1993).

D...
 I...
 அ...
 S...
 அ...

G...
 அ...
 அ... Pa... (E.1)
 அ...
 அ...
 அ...

4. – **ff c a d R f E a**

Geome r	P	R	Dimen ion
Infinite slab	1/2	1/8	thickness e
Infinite cylinder	1/4	1/16	radius r
Sphere	1/6	1/24	radius r

$$t_F = \frac{\rho \lambda_i}{T_F - T_e} \left[\frac{e^2 R}{k} + \frac{eP}{h} \right] \quad (\text{Pa ...})$$

1980).

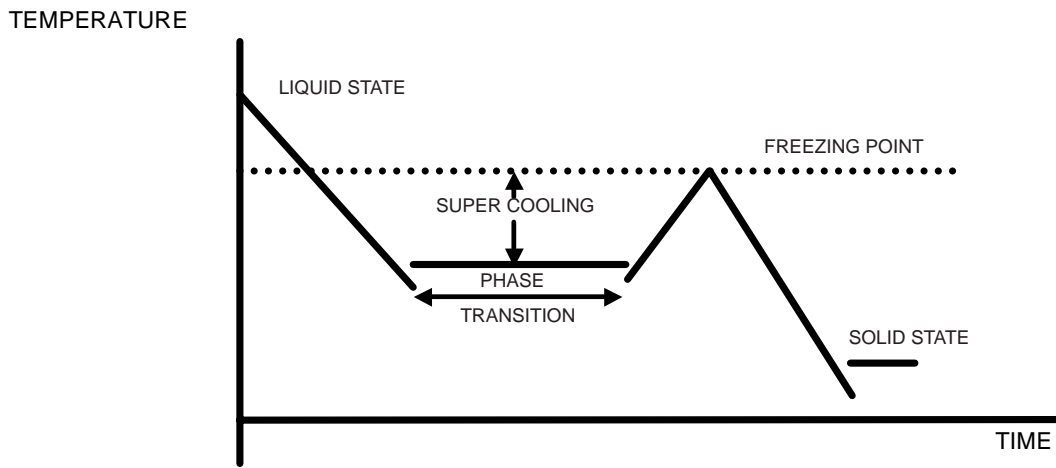
(1)

W λ_i a a a , a l ρa a l a l
 l a *W* a a
 l a l a l a l a l a
 a *W* a a a l Pa g
 a 4a l a a g l a l g g l *W*
 l l (... a g , a a l
 l a l *W* l a l l
 ...).

A l a , a Pa a l a a g
 a a a g g g g *W* , l a
 a a a g a g a a g l
 l l l , a l a a a
 a (Ba a -Ca a a l Ia , 2002).

S
Nga a a, (1955). Nga a' a (E . 2) a a a a
a a a a a a a a a a a a
a a a a a a a a a a a a
a a a a a a a a a a a a
a a a a a a a a a a a a

Fig. 4. Freezing curve



The... a... g... a... a... a...
 g... a... a... a... a... a... a... a...
 (a... , 1999). g... 4... a... a... a... a...
 g... a...

a... g... a... a... g... a... l... w... l... a...
 a... g... l... w... a... g... l...
 S... a... , l... a... a... a... a... a...
 l... a... a... a... a... a... g... a...

$$\Delta H = \left[1 - \frac{X_{SNJ}}{100} \right] \Delta H_f + 1.21 \left[\frac{X_{SNJ}}{100} \right] \Delta T$$

(H... a... l... K... ,

1996).

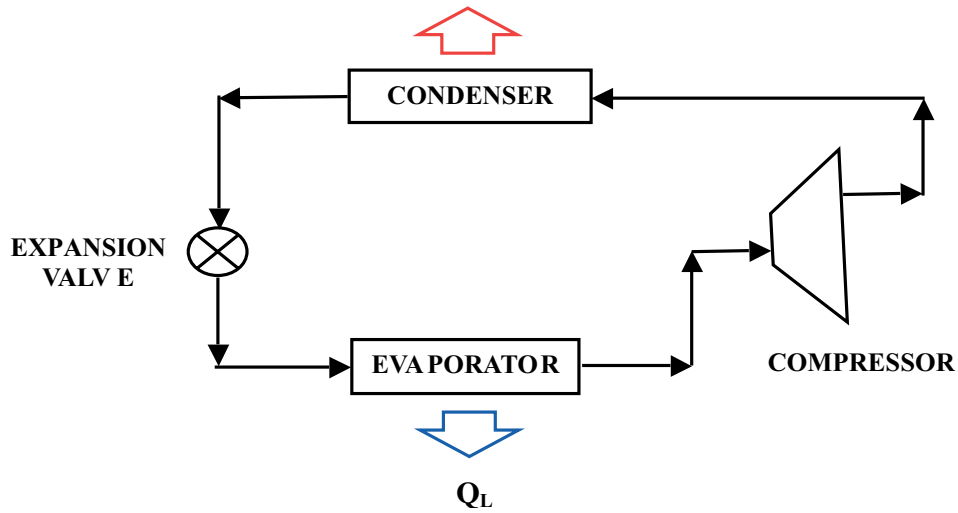
F... a... l... g... a... , a... g... l... g... a... a... l... a... l...
 a... a... g... a... l... a... l... w... g... a...
 l... l... (1949) a... a... g... a... a... l... a...
 g... a...

$S_{NJ} : P$ a g u l l l (D a a)
 $\Delta H : E$ a a g l g g a
 $\Delta :$ a l a a l a a

1.2.3 Ref ige a ion

a l l a a a a a a a a a
 a a a l g u . a a a a
 a g u a l g u a g u l a a
 g . A l g l a , a
 a a a a a
 a a a a a
 a a a a a

Fig 5. A c f r a a c c a c a r f r a
 Ada d fr S c r F a d R fr ra a d Ar - d
 c ra H r

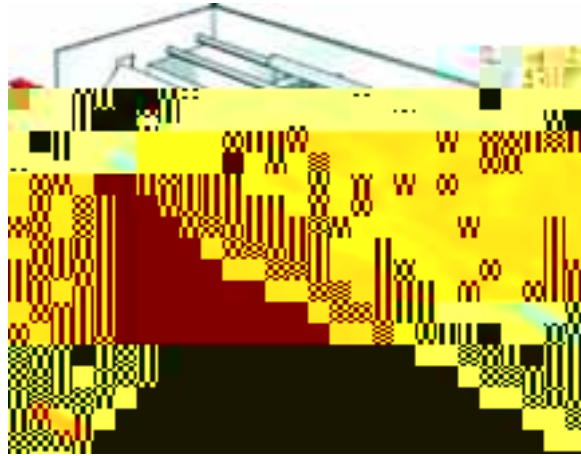


a . F a , l a a g u a
 (LIN) a l l (CO₂), a l l
 a a a a g u a a l l
 a a a a a a a a a
 (HCFC) a l a a a a a

a l a a a a a . A
l a a a a w Fg 5.

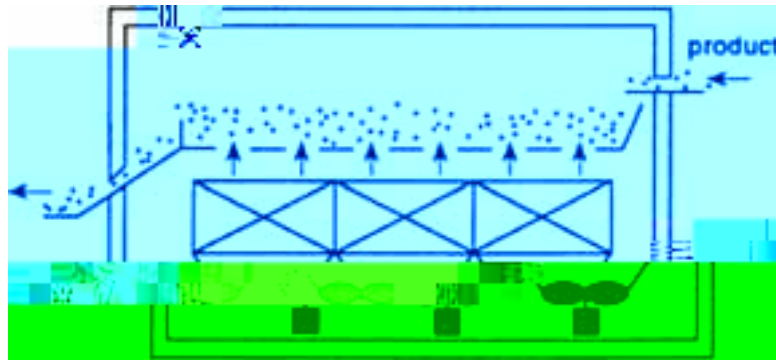
S a a a , l a a a l
w a a a a a l a a l
a a l a . A a a a a l a a l
l w a a a w l a l
a a l a . F a , l a w a
a a w l a a a l a a l a
a a a a a a a a a

Fig 9.-r c a f a f d d d f r r
- r f Fr ca da E L d



a a l a l a l a l a a a a a a
a a l a a a a a a a a a a a
a a C a a a a a a a a a a
a a a l a a a a a a a a a a a
l, a a a a l a a a a a a a a
l, a a a a a a a a a a a a a
a a a a a a a a a a a a a a
a a l a a a a a a a a a a a a
a a a a a a a a a a a a a a

Fig 9.S r r c f a f d d d f r r
Sara ac ar A E



T fr r

I l a a a l a a l w
l a a l . I l a w a a , a
l l w a w a l a l
a a . g a a
l , a g a a a a l g
g a w a l g , a g , a l a a a (M , 1993). A
a w Fg 7.

B fr r

B w l g l l w a
w l a . A a a a l

a a a w l l l g a a
a w a g l a . A w a g l a w
l w l l l . I

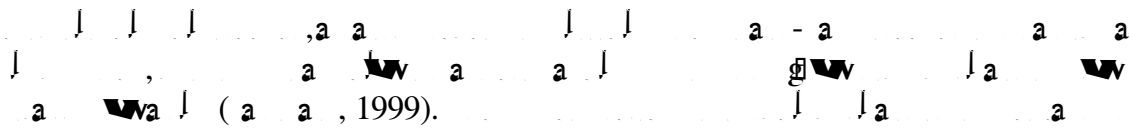


Fig. 11. Spray freezer

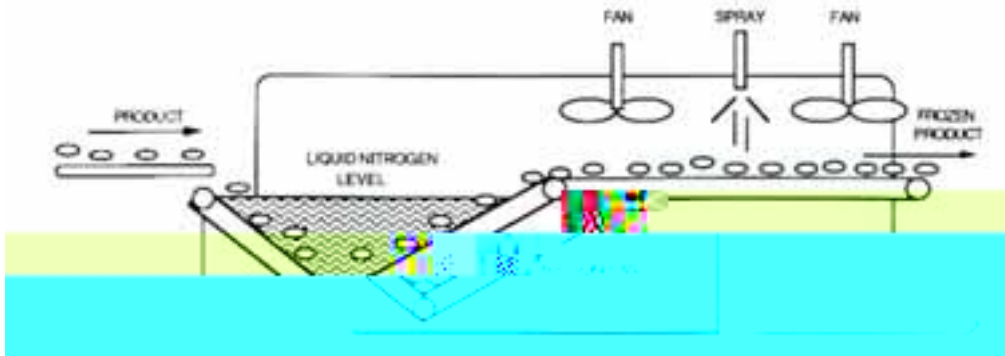


Fig. 12. Direct air freezer

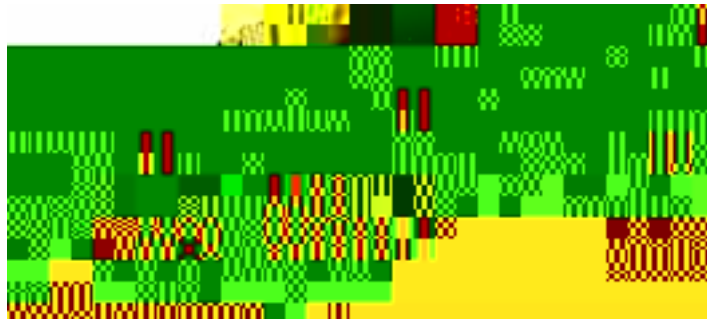
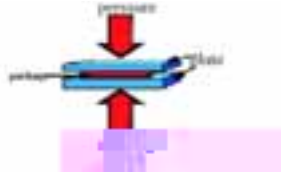


Fig. 13. Direct air freezer (Guthrie, 1993).

The spray freezer is a type of direct air freezer. It is used for freezing of small pieces of food. The product is fed into the freezer through a hopper and is frozen by the action of the spray of liquid nitrogen. The frozen product is then collected in a container.

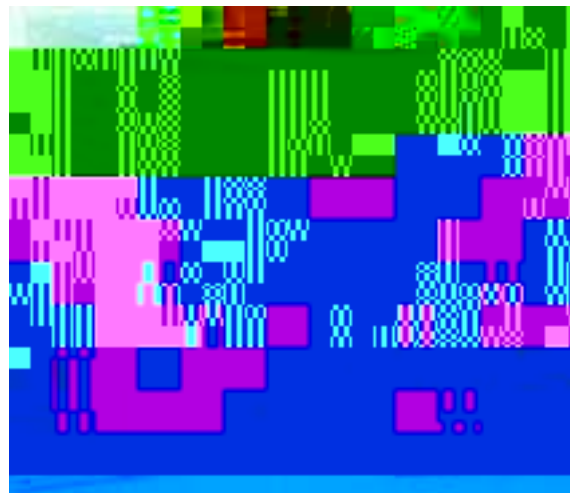
The direct air freezer is a type of indirect air freezer. It is used for freezing of large pieces of food. The product is fed into the freezer through a hopper and is frozen by the action of the air. The frozen product is then collected in a container. (Pala, 1993). The direct air freezer is also known as the IQF (Individual Quick Freezing) freezer.

Fig 13. r r a ca a a fr r



... IQF ... S ... A ...

Fig 13. a fr r a a c r r a d a a r c d r
- r f SI Sa f Fr r Sr I



C a ... I ... F ... A ... Fig 10. F ... (M ..., 1993).

I r r

... .. a a ... a a, a
... .. , l , a , a l a a l
... .. l a
... .. , .. a l a a a .. (H .. a l

Fg 14. - ac fr r
- r f Fr ca da E U d



K , 1996). D a l a l .. a a l
... l a a l .. a a ..
... l a a , l , .. a .. a l
... l .. a .. l .. a ..
I a .. l .. a ..
a .. l .. a .. l .. l a a
... .. A l ..
... .. l a a .. a a l .. a a ..
... .. a l .. l .. a .. l .. a , .. a
a .. l (G .. , 1993). A .. a ..

Fg 11.

I d r c c ac fr r

I , a a .. a a a l .. a a
... .. l .. a a , a a a .. a .. l .. a
... .. Fg 12. I l .. a .. a l .. a .. l
a a .. , a .. a .. a .. a .. l

a a g l l l a a a g a a . All a ,
a a a a a g W a a a .

a fr r

a a a . I a , l
l W a W a a , a a W a
g a a g l a . P a l g l a a
a a W Fg 13 .

g a - a l a a
a - a l a a g l l . A a a W
Fg 13 .

- ac fr r

l g W g - a l l - a l g
l a a W Fg 14 . l g a a g W a l
l a l a , g g , a a l
(P a l L la , 1993).

C g g a a W l g W l l l
a a W -60 C g l a W l g a a
g a l l (H g a l K , 1996).

g a a a ; g a
l a l a g l a a a a l l - g
a a a l g
a W l g a l g a a . W a
a l a g a g a a g (P
a l L la , 1993).

L d r fr r

L l g W a g a -196 Ca a , a -
l g a a g a a l a l
a a , a l

L ... car ... fr ... r ... a ... a ... -70. C, a ... a ... (G ..., 1993).

1.2.7 Packaging

P ... a a a a ... a ... a ... a ... (a a , 1999). P ... a ... S ... (H a a C , 1993).

P a a a a ... -a - ... a a , ... O ... a ... (A H AE, 1994; a , 1996). Ga a l l a a ... S ... M a a a a , ... M a a a a ... I ... a ... D a a a a ... S , 1999).

A a a a a a a , a ... l a a l a l - l l ... a a a a a a a ... Wa l ... Ga a a a l l a a ... Pa a a l a - a a ... (B l ,

Raw materials
(... ..)

at rit assessme t

Pre arati
(... ..)

1.3.1 Freeing f i

..... ϕ , $a\phi$, a ! \mathbb{W} ϕ a a

C... la... a... a... l... a...
... I... a... l... a... l... a...
... a... a... a... a... a...
a... l... a... a... a... a... a...

... ad... a...
F... a... a... a... a...
a... l... a... a... a... a...
a... a... a... a... a...
a... l... a... a... a... a...
a... a... a... a... a... a...
a... a... a... a... a... a...
(... , 1984).

F... a... l... l...
P... l... a... l... (B... l...
l... , 1968).
a... l... a... (... , 1985), a... a... (G... a... , 1990), a...
a... (G... a... M... , 1992). a... a... a... l... l... a...
l... a... a... a... . A... a... a...
a... a... a... l... a... a... a... a... . B... a...
a... a... a... a... a... a...
a... (... l... , 1996).

a... a... a... a... a... a...
l... , a... , a... a... , a... a... a...
a... (G... l... , 1968). a... a...
a... l... a... a... a... a... a...
a... a... l... a... l... a... l... a...
a... a... l... a... a... a... a... (... , 1984).

... d...
All... a... a... a... a...
a... a... a... l... l... a...
a... a... l... a... a... a... a... a...
a... a... a... a... a... a... a...
a... a... a... a... a... a... a...

1978). S... a... 30-60... (M...-D...),
 S... a... a... a... a... (G...),
 1968).

F... a... la... la...

Fruit	Preparation	Pack
Apples	Wash, peel, and slice into antidarkening solution -- 3 tablespoons lemon juice per quart of water	Pack in 30-40% syrup, adding 1/2 teaspoon crystalline ascorbic acid per quart of syrup. Pack dry or with up to 1/2 cup sugar per quart of apple slices.
Apricots	Wash, halve, and pit.	

... a l l a l , ...
... P - a l , ...
... a , a a

e, a, d, a d a,
... a a l a a l a
... a a a a a a a a a a
... a l a a a , l , a , a a
... a a , a a , a l a

... a l a l a a a
... a a a (G , 1996): S

- S a a a a a
- E a a a l a l l a
- H a l a

A a a a a a a a a l ,
a a l a l a l a a a a a a
a a a a l a a a a a a a
a l a a a a l a a a a a
a a l , a l a l l
a a l a l a l l l
a a l a l a a a a a a a
a a l a l a (H a , 2004).

a
A a a a a a a a a
a l , l a a a a a (A , 1993).

S a a a a l a a a l l a
I a a l a l l a a a
l a a l a a a (L , 1989). M
a a l a a a

e e e	Pre r ion	n ree e
-------	-----------	---------

Asparagus

Wash and sort by size.
Snap off tough ends.

Cut stalks into 5--2q1Tf0.74 03.49D0.0027 (04 1 Tf 0.8949 0 40.0019 Tc (ut)-27m1(nt1 nT q 1Tf 6.4 0))10J787

கு அ அ அ அ அ அ | அ அ | கு. P அ | அ
 அ | கு கு அ அ | அ | அ அ அ , , அ |
 (L, 1989). , | அ | அ அ அ | கு |
 | | அ அ அ | கு. C கு கு அ | அ , அ
 அ கு, | அ | அ - அ , | கு
 அ | கு அ அ அ கு | அ அ | அ
 | அ | கு அ (D, a, 1977).

Ba e...

Ba கு கு அ கு | அ | அ அ அ |
 அ அ | . Pa அ கு அ (| அ | கு
) | அ | அ | அ | | கு, அ கு
 | அ | அ | அ கு அ | அ | அ | அ | அ |
 அ அ , | அ | அ அ அ , அ , | அ |
 . I கு அ அ அ | , | அ |
 அ | கு அ கு அ | அ அ கு அ | கு |
 அ அ | . Ba கு அ அ | கு கு அ , அ கு
 அ அ | . I | அ அ அ | அ அ |
 (D, a |, 1977).

Ba கு | அ அ 70 105 C அ அ அ |
 அ | . Ba கு அ அ | | 75a | 95 C | 10
 , | கு | | அ கு அ (H |, 1983).
 Ba | கு அ | | | அ |
 | கு அ | அ | அ - அ (D, a, 1977).

| அ | அ | அ | அ | அ | அ | அ | அ |
 | அ , அ அ , அ | கு அ . P | அ அ அ
 | கு அ | , | அ | அ | அ |
 அ அ (A, 1993).

கு அ அ அ அ | | அ , அ , அ | | அ . H |
 அ கு | | அ | கு கு அ | . Ba கு
 | | அ அ கு அ கு | அ | 6 | அ அ
 அ அ அ அ | | கு | | | . F | அ கு,
 கு அ அ அ அ அ | அ | அ | | அ |
 | . கு கு | அ (A, 2003), அ அ கு அ கு அ
 | , | அ | - | | அ | - | அ |



G a a a | a a | g a a g
a a a a a | a a | a a |
a a a a | g a a | a a | g

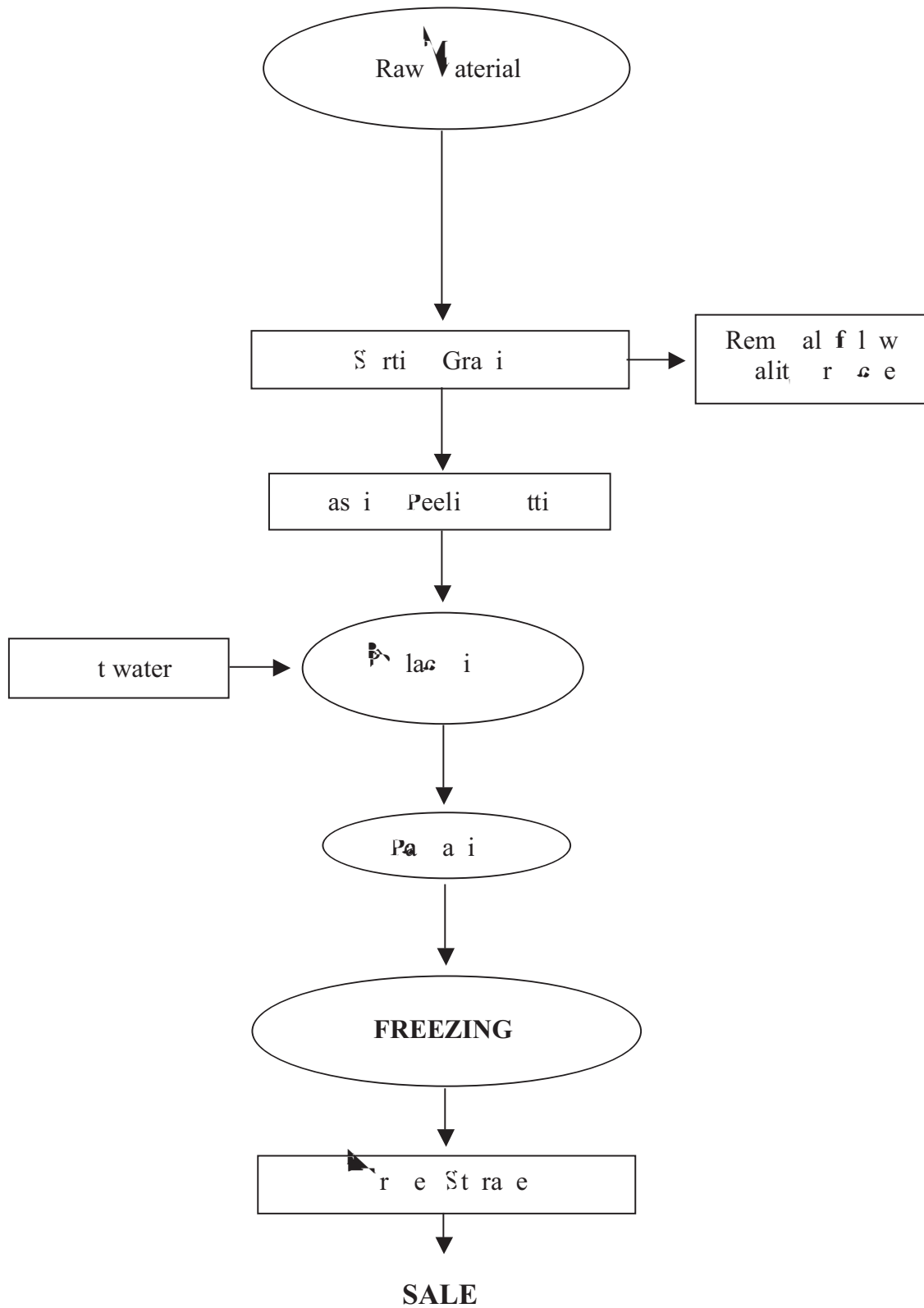
.1

O a a a | a a a a |
a a a a | a a a a |
a a a a | a a a a |
a a a a | a a a a |
a a a a | a a a a |
a a a a | a a a a |
a a a a | a a a a |
a a a a | a a a a |

Fig. 16. Ra rr a d ac rr

P l g l

Fig 19. F... a r a f f r r c f a a d r d c



I a
 l
 a (Ma, 1993).
 la
 w (H, 1968). A 18a l 19
 la
 l a

2.3.1 *oca ion*

- A a
 a
 F
 g

2.3.2 *Gene al plan la o*

- P l
 a
 w
 w
 a
 w
 a
 a
 a
 D
 l, a
 Fa
 a
 P
 a
 A
 l
 a
 w
 a

- l a g h a , l , a a l a **Wa**
 a . a a g h a l a g h a a a l a
 a a l a a a g h l a .

E a l a l a g h a a g h a a .
 a l , a l l g h a l a **W**
 g h l a l l (H , 1968).

Ca 3

V

... a ... a a a | a | ... a
... a | ... a | a | a | I a a ,
... a | a | a | a | a |
... a a .

7.1
... a | ... -a | a | g a -a | a a a
W :

F -a | a
... a , a , g a (40)
... a | a
G , g a , a W ,a |

7.
A | a | ... , | a a
a | a | ... g a .
... a a | | .1000 g | (g a) Wa
| a a a - a a W a g a | g a
a a a | a | a | a | a | a
a a a | a | a | a | a | a | a
C a a a a | a | a | a | a | a | a
... g a g a - a a . C | g | | a
a | a a ,a | a | a | a | a
W a a 414 Wa a | g a | a |
g a . W Fg 20.

CF146

Fig. 20. a - Fertilization of the egg



77. *Figure 20. a - Fertilization of the egg*

The egg is fertilized by the sperm. The fertilized egg is shown in the center of the petri dish. The egg is surrounded by a layer of cells, which are the cells of the egg. The egg is fertilized by the sperm, and the fertilized egg is shown in the center of the petri dish.

78. *Figure 20. b - Fertilization of the egg*

Fertilization of the egg is shown in the center of the petri dish. The egg is surrounded by a layer of cells, which are the cells of the egg. The egg is fertilized by the sperm, and the fertilized egg is shown in the center of the petri dish. (Baker and Falck, 1987). Fertilization of the egg is shown in the center of the petri dish. The egg is surrounded by a layer of cells, which are the cells of the egg. The egg is fertilized by the sperm, and the fertilized egg is shown in the center of the petri dish.

Cultivation of the egg is shown in the center of the petri dish. The egg is surrounded by a layer of cells, which are the cells of the egg. The egg is fertilized by the sperm, and the fertilized egg is shown in the center of the petri dish. (Johnson, 1994).

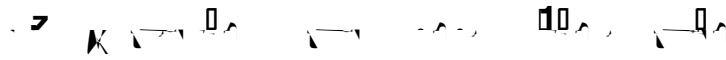
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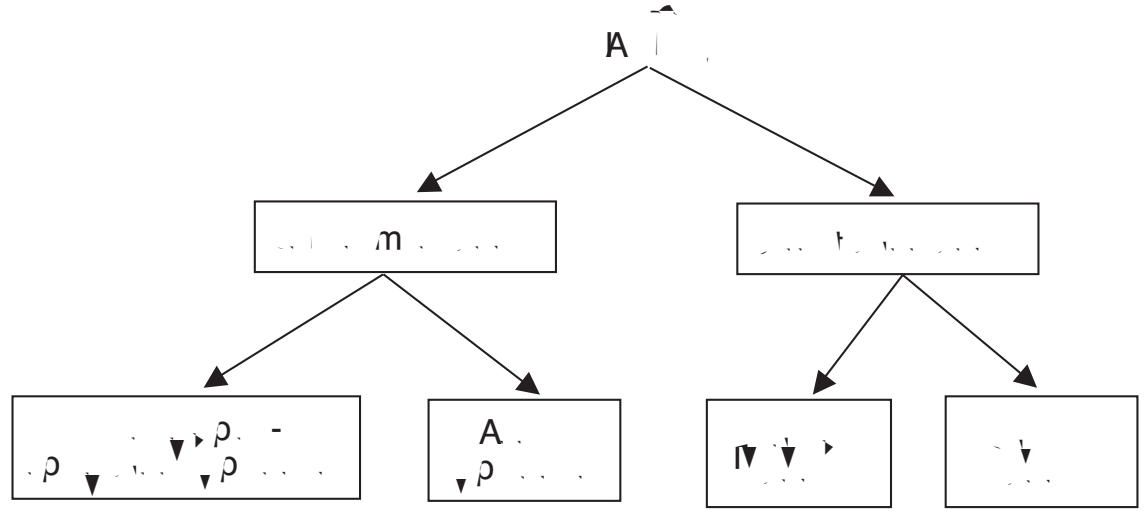
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(10. ...):

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F.1

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- a a a l a ;
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F l ... a a ... a ... a a l l ... a w
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Ab e : a

1. G a a a : C l g \$ 300 () a a
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2. C g a g a a l a l a a , w
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P l a : 1 000 g g a
 (2 000 a a g) ;
 F a a : 40 g l 20 ;
 g a a : 500 a ;
 A a g : \$ 0.10 / ,
 w : 1.5 500 = 750 / ;
 750 a S \$ 0.10 / = S \$ 75 / .

3. *G a w a a a l 100 g l*

<i>R m eri n ie 100 e e e</i>				
<i>R eri</i>	<i>n i</i>	<i>ni Co</i>	<i>o Co</i>	
C ()	25	1.25	31.25	
G B ()	25	2.50	65.50	
O ()	25	1.25	31.25	
C ()	25	2.00	50.00	
()	500	0.01	5.00	
P M	200	0.05	10.00	
			O AL	\$ 193.00

4. *G a w a a a l 1 000 g l*

w a a a l : \$ 193 10 = \$ 1 930.00
la : S \$ 600.00
E g : S \$ 1 330.00
T a a r a c S

F. d e : a

1. *G a l a :*

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a a = \$ 1 400.00
A a l a S \$ 1 400 / 8 = \$ 175
M l a S \$ 175 / 12 = S \$ 14.58

2. G a a a l a a a :

D a a a :	\$ 14.58
A l a a :	\$ 00425.00
T a f d c	\$
a a a a :	\$ 2 605.00
a a l :	\$ 00439.58
T a r d c c	\$

Ca a ... a a ... a l ... a , d ... P l ... a
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$$(\text{... a a g}) = \$ 3\,044.58 / 2\,000 = \$ 1.52$$

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l ... E l a a a l a l g
W g a :

$$M = F l / (\text{... l ... a a ...})$$

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ar a - r ac a S

$$M = \$ 439.58 / (\$ 3.20 - \$ 1.30)$$

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i m n r o i e i n e e n i i r f o r m i o n o n f r e e i n e n o o o r e e r e
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r o i n o n m e r e m n f o r f r o e n f o o i n e e o i n o n r i e

