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Physico-chemical changes in bottle gourd (Lagenariasiceraria) juice during storage

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Abstract: ***The present study was designed to evaluate physico-chemical changes in bottle gourd juice during storage. The fresh bottle gourds were procured from the Agriculture Farm, Haryana Agriculture University, Hisar, India. The bottle gourd juice was extracted and treated with citric acid and potassium metabisulphite. Extracted juice was filled in glass bottles and stored under refrigerated (4-7°C) and room temperature (27±2°C) conditions for 15 days. Total soluble solids, pH, acidity, nonenzymatic browning and color of juice were analyzed during storage. Bottle gourd juice stored under room temperature initiated spoilage (5 days) much before refrigerated temperature (10 days). The colour of juice gradually changes with increase in non-enzymatic browning during storage period. The other changes in terms of pH, total soluble solids and titratable acidity were not found significant during storage.***
Keywords: Bottle gourd, juice, non-enzymatic browning, physico-chemical characteristic, refrigerated storage

I. INTRODUCTION

Bottle gourd is one of the excellent vegetable having most of essential nutrients that are required for a healthy life. Bottle gourd (*Lagenariasiceraria*) belongs toCucurbitaceae family and commonly known as lauki, dudhi or ghiya in India. Bottle gourd has been cultivated since time immemorial and it is most probably one of the earliest vegetable cultivated by man. This is one of the most important summer season cucurbitaceous vegetable but cultivated in India almost round the years. It is reported to have originated in Africa and widely cultivated throughout the tropics, especially in India, Sri Lanka, Indonesia, Malaysia, Philippines, China, Tropical Africa and South America.

Bottle gourd is one of the most favourite vegetables of Indians and has numerous health benefits. It has the highest content of choline among all the vegetables known to man till date, which serves as the precursor of neurotransmitter acetylcholine, which in turn is crucial for retaining and enhancing memory [1]. Recently due to health consciousness among people there is a shift of preferences towards the consumption of more fresh vegetables and their products, including beverages. The vegetable is reported to contain the tri-terpenoidcucurbitacins B, D, G, H and 22- deoxycucurbitacin the bitter principle component of cucurbitaceae [2].

Bottle gourd juice has tremendous medicinal significance and the vegetable is not only a rich source of essential minerals, iron, protein and trace elements but also possess high fiber content and functional properties. It is a good source of vitamin B complex and a fair source of vitamin C [2]. The freshly extracted juice serves as a valuable medicine for excessive thirst due to severe diarrhea, diabetes and is used in the treatment of epilepsy, stomach acidity, indigestion, ulcers as well as other nervous diseases [3]. In addition to this, the fiber portion helps in preventing constipation and other digestive disorders like flatulence and piles. Ghule et al. [4] reported anti-hyperlipidemic and anti-inflammatory activity from extracts of bottle gourd. The fresh juice of the fruit also have antiulcer activity [5], hepato-protective, free radical scavenging activity [6], immuno-modulatory and cardio protective activity [7] in different animal model systems. This commonly available vegetable is very effective in treating urinary disorders, jaundice and proved to be contributing in loosing extra body weight.

According to a recent report, the vegetable when eaten raw may harm the stomach and intestinal mucosa, so cooking of bottle gourd should be preferred which is also antibilious in nature. The cooked vegetable is cooling, sedative and gives a feeling of relaxation after eating and its leaves in the form of decoction with sugar are used for curing jaundice. Since bottle gourd being a perishable vegetable suffers high post-harvest losses [8].

There are lots of health benefits of bottle gourd, therefore the present study was aimed to evaluate the quality changes in juice stored at ambient temperature as well as at refrigeration temperature up to 15 days of storage.

II. MATERIALS & METHODS

A. Raw Material: Tender and freshbottle gourds were procured from the Agriculture Farm, Haryana Agriculture University, Hisar, India.

B. Chemicals: All the chemicals and reagents used during research work were analytical grade. Anthrone reagent was procured from Sigma-Aldrich Chemical Co. (St. Louis, USA). Ammonium molybdate, citric acid, potassium metabisulphite (KMS), folinciocalteu phenol reagent, sodium hydroxide, sodium carbonate, sodium bicarbonate, sodium sulphate, sodium hydrogen arsenate, sulphuric acid, tannic acid were procured from Fisher Scientific India Pvt. Ltd. (Mumbai, India) and copper sulphate, potassium sodium tartrate were procured from SD Fine-Chem Ltd. (Mumbai, India).

C. Extraction and processing of bottle gourd juice: Fresh, tender and mature bottle gourd of uniform light green color subjected to various preliminary treatments like sorting, cleaning, washing and trimming. Mature fruits were sorted on the basis of presence of uniform inner white color, immature seeds and free from dirt, woody fibrous tissues, dry rot, sunburn, green cores, pithy cores and injuries caused by insects, rodents or mechanical damages, followed by soaking in water to soften adhered soil, sand etc. Then bottle gourds were washed under running water to remove dirt, filth and sand etc. After washing the crown portions were removed. Then bottle gourd was sliced into small pieces. Extraction of juice was carried out by Electric juicer (Philips HL1631/J Juicer, Philips India Limited, Kolkata, India). Citric acid and KMS were added (350 ppm) to fresh juice as preservative and stored in sterile glass bottles under refrigerated condition (5±1°C) and at room temperature (27±2°C) separately for 15 days with periodic evaluations after every 5 days (figure 1).

D. Analytical methods: The stored juice samples were subjected for quality evaluation by assessment of the physico-chemical changes during storage. The pH of juice samples was measured by digital pH meter (Thermo Orion, 420A+, Thermo Fisher Scientific Inc, USA), Total soluble solids (TSS) was measured using hand refractometer (ERMA, Tokyo, Japan, 032° Brix range), titratable acidity (as citric acid) was determined by the methods as described by Nath and Ranganna [9], Extent of color changes were measured using Lovibond Tintometer (Model F, Camlab, UK). The color was expressed as combination of red, yellow and white color according to the color of the sample. The change in absorbance of samples was measured at 440 nm using double beam, UV Spectrometer (Thermo scientific, USA) for nonenzymaticbrowning as described by Ranganna [10]. All estimation were carried out in triplicates at interval of 5 days.

E. Statistical analysis: Means, standard deviation (SD), linear regression analysis and 95% confidence intervals were calculated using Microsoft Excel 2007 (Microsoft Corp., Redmond, WA). The results obtained were subjected to Three Factor Analysis using Online Statistical Analysis software (OPSTAT, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India).

III. RESULTS & DISCUSSION

The physical characteristics of fresh bottle gourd along with its proximate analysis are given in the table 1. Moisture, ash, protein, fat and vitamin C content of bottle gourd fruit were determined to be 94.65%, 0.49%, 0.18%, 0.09% and 7.5 mg/100g respectively. Similar results were obtained by Chawdhary [11], who reported 96.1% and Gopalan et al. [12] reported 96% moisture in fresh bottle gourd. While mineral matter, protein, fat and vitamin C content observed by Chawdhary [11] were 0.5%, 0.2%, 0.1% and 6mg/100g respectively. These differences may be due to varietal difference, seasonal variations and cultivation conditions of bottle gourd used.

A. Physico-chemical changes: he extracted juice was analyzed for their Physico-chemical composition (table 2).

B. Total Soluble Solid (TSS): The TSS of bottle gourd juice (4.03ºB) decreased significantly during storage up to 15 days. The decrease in TSS was observed more at room temperature than at refrigerated condition (table 3). It may be due to comparative high pH which was conducive for the growth of microorganism and consumption of sugar by microorganisms to carry out fermentation. Similarly, Sahu et al. [13] reported that decrease in TSS of whey based mango-herbal beverage during the storage of two months whereas Dhaliwal and Hira [14] observed no significant changes in TSS of four different combinations of carrot juice with two levels each of beet root (5 and 10%) and black carrot (10 and 20%).

C. pH and acidity: A significant decrease in pH along with increase in acidity was observed in bottle gourd juice (table 4 & 5) during storage. The decrease in pH was more at room temperature than refrigerated condition. The increase in acidity and

decrease in pH is correlated and more pronounced during storage. A slight decrease in pH during storage in bael nectar and squash was also reported by Roy and Singh [15]. Our results are in accordance with the results of Bowen and Macgregor [16] during storage in case of apple wine. Dhaliwal and Hira [17] found slight decrease in pH content of carrot juice blended with spinach juice and pineapple juice.

D. Non-enzymatic browning: A gradual and significant increase in non-enzymatic browning was observed during storage. Increase in non-enzymatic browning was more in samples stored at room temperature than refrigerated condition(table 6). The increase in non-enzymatic browning during storage might be due to reaction of organic acid with sugars or oxidation of phenol, which leads to the formation of brown pigments [18]. Kapoor et al. [19] observed that the fructose exhibit maximum browning, while glucose has minimum browning. Many acids such as oxalic acid and pyruvic acid were found to cause maximum browning with fructose and sucrose. Phenolic compounds may interact to give different brown colored product enhancing browning. Tiwari [20] reported an increase in non-enzymatic browning value during storage of guava papaya (70:30) blended RTS beverage.A slight increase in acidity and slight decrease in pH during storage in nector and squash of bael was reported by Roy and Singh [15].

E. Color: There was drastic change in colour during storage mainly due to effect on red and yellow colour as compared to white color in different samples (table 7). There was decrease in red and yellow color units while little effect on white color during storage of different juice samples. During the storage period dullness of color was increased.

IV. CONCLUSION

It was concluded that during storage the shelf life of juice was 4 to 5 days at room temperature and 10 days at refrigeration temperature. Non-enzymatic browning content increased during storage. After the storage period of 15 days the juice becomes dull and brownish in color. The change in pH, total solids and acidity was not significant. The color of juice gradually changes with increase in non-enzymatic browning during storage period. It may be concluded that the juice stored at refrigerated condition upto 10 days had comparative physico-chemical properties and suitable for consumption.

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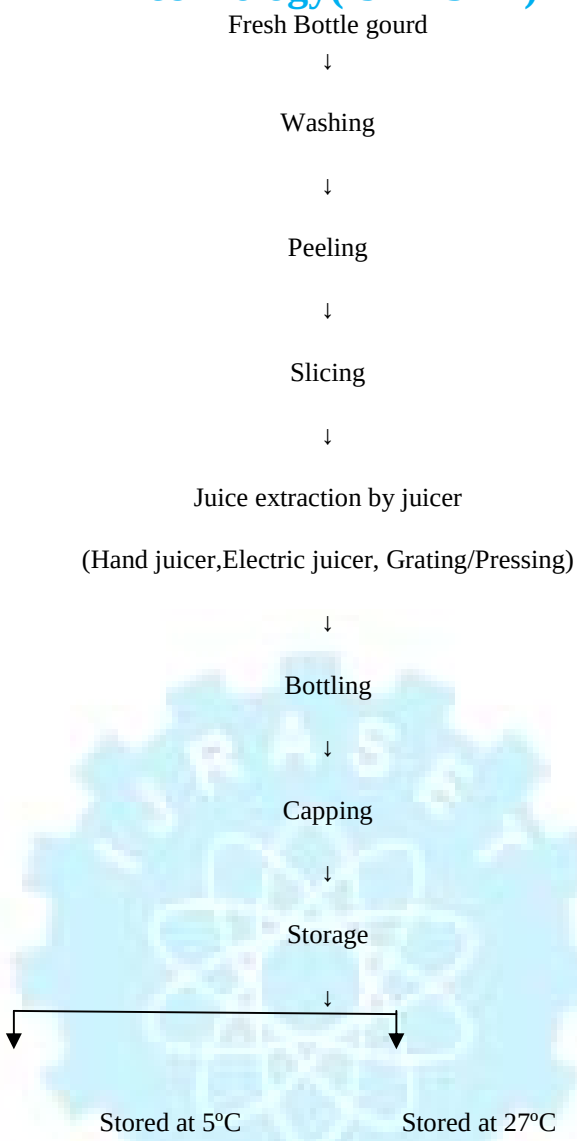


Fig. 1 Method of preparation of bottle gourd juice

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Table 1. Proximate analysis of bottle gourd fruit

Parameters	Mean Value (%)
Moisture	94.65±0.02
Ash	0.49±0.01
Protein	0.18±0.01
Fat	0.09±0.01
Vitamin C (mg/100g)	7.5±0.1

Data are presented as mean ± SD (n=3).

Table 2. Physicochemical composition of bottle gourd juice

Parameters	Value
TSS(ºB)	4.03±0.01
Acidity (%)	0.08±0.01
pH	5.3±0.01
Tannin content (mg/100ml)	81±0.1
Reducing sugar (%)	3.2±0.02
Total sugar (%)	4.2±0.01

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Table 3. Changes in the total soluble solid (TSS) content (°Brix) of bottle gourd during storage[1]

	0 days	5 days	10 days	15 days	Mean
TREATMENT					
Control	4.067±0.05	3.767±0.05	3.667±0.05	3.567±0.05	3.767
Refrigeration Temp.	4.033±0.05	3.867±0.05	3.833±0.05	3.767±0.11	3.875
Mean	4.050	3.817	3.750	3.667	3.821
Control	4.133±0.05	3.967±0.15	3.533±0.11	3.100±0.10	3.683
Room Temp.	4.167±0.05	3.867±0.05	3.833±0.05	3.533±0.05	3.850
Mean	4.150	3.917	3.683	3.317	3.767
MEAN					
Refrigeration Temp.	4.100	3.867	3.600	3.333	3.725
Room Temp.	4.100	3.867	3.833	3.650	3.871
OVERALL MEAN	4.100	3.867	3.717	3.508	

[1]Data are expressed as mean ± Standard Deviation

Critical Difference: Treatment (A) = 0.044, Temperature (B) = 0.044, Storage period (C) = N.S.
Factor A * B = 0.062, Factor A * C = 0.088, Factor A * C = 0.088, Factor A *B * C= 0.125

Table 4. Changes in the pH content of bottle gourd juice samples during storage[1]

	0 days	5 days	10 days	15 days	Mean
TREATMENT					
Control	5.067±0.05	4.867±0.05	4.633±0.05	4.467±0.05	4.758
Refrigeration Temp.	4.867±0.05	4.767±0.05	4.433±0.05	4.300±0.00	4.592
Mean	4.967	4.817	4.533	4.383	4.675
Control	5.067±0.05	4.667±0.15	3.100±0.1	2.767±0.10	3.900
Room Temp.	4.867±0.05	4.667±0.05	3.767±0.05	2.967±0.05	4.067
Mean	4.967	4.667	3.433	2.867	3.983
MEAN					
Refrigeration Temp.	5.067	4.767	3.867	3.617	4.329
Room Temp.	4.867	4.717	4.100	3.633	4.329
OVERALL MEAN	4.967	4.742	3.983	3.625	

[1]Data are expressed as mean ± Standard Deviation

Critical Difference: Treatment (A) = 0.035, Temperature (B) = N.S, Storage period (C) = 0.050
Factor A * B = 0.050, Factor A * C = 0.070, Factor A * C = 0.070, Factor A * B * C = 0.099

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Table 5. Changes in the acidity content (citric acid) of bottle gourd juice during storage[1]

	0 days	5 days	10 days	15 days	Mean
TREATMENT					
Control	0.087±0.05	0.110±0.00	0.143±0.05	0.207±0.05	0.137
Refrigeration Temp.	0.090±0.00	0.097±0.05	0.130±0.00	0.177±0.05	0.123
Mean	0.088	0.103	0.137	0.192	0.130
Control	0.087±0.05	0.150±0.00	0.187±0.05	0.267±0.05	0.173
Room Temp.	0.083±0.05	0.117±0.05	0.157±0.05	0.230±0.05	0.147
Mean	0.085	0.133	0.172	0.248	0.160
MEAN					
Refrigeration Temp.	0.087	0.130	0.165	0.237	0.155
Room Temp.	0.087	0.107	0.143	0.203	0.135
OVERALL MEAN	0.087	0.118	0.154	0.220	

[1]Data are expressed as mean ± Standard Deviation

Critical Difference: Treatment (A) = 0.003, Temperature (B) = 0.003, Storage period (C) = 0.004 Factor A * B = 0.004, Factor A * C = 0.006, Factor A * C = 0.006, Factor A * B * C = N.S

Table 6. Changes in the non-enzymatic browning of bottle gourd juice samples during storage[1]

	0 days	5 days	10 days	15 days	Mean
TREATMENT					
Control	0.987±0.00	1.043±0.01	1.080±0.00	1.107±0.00	1.054
Refrigeration Temp.	0.980±0.00	1.007±0.05	1.047±0.05	1.077±0.05	1.028
Mean	0.983	1.025	1.063	1.092	1.041
Control	0.983±0.05	1.203±0.05	1.303±0.05	1.503±0.05	1.248
Room Temp.	0.980±0.00	1.103±0.05	1.203±0.05	1.453±0.05	1.185
Mean	0.982	1.153	1.253	1.478	1.217
MEAN					
Refrigeration Temp.	0.985	1.123	1.192	1.305	1.151
Room Temp.	0.980	1.055	1.125	1.265	1.106
OVERALL MEAN	0.983	1.089	1.158	1.285	

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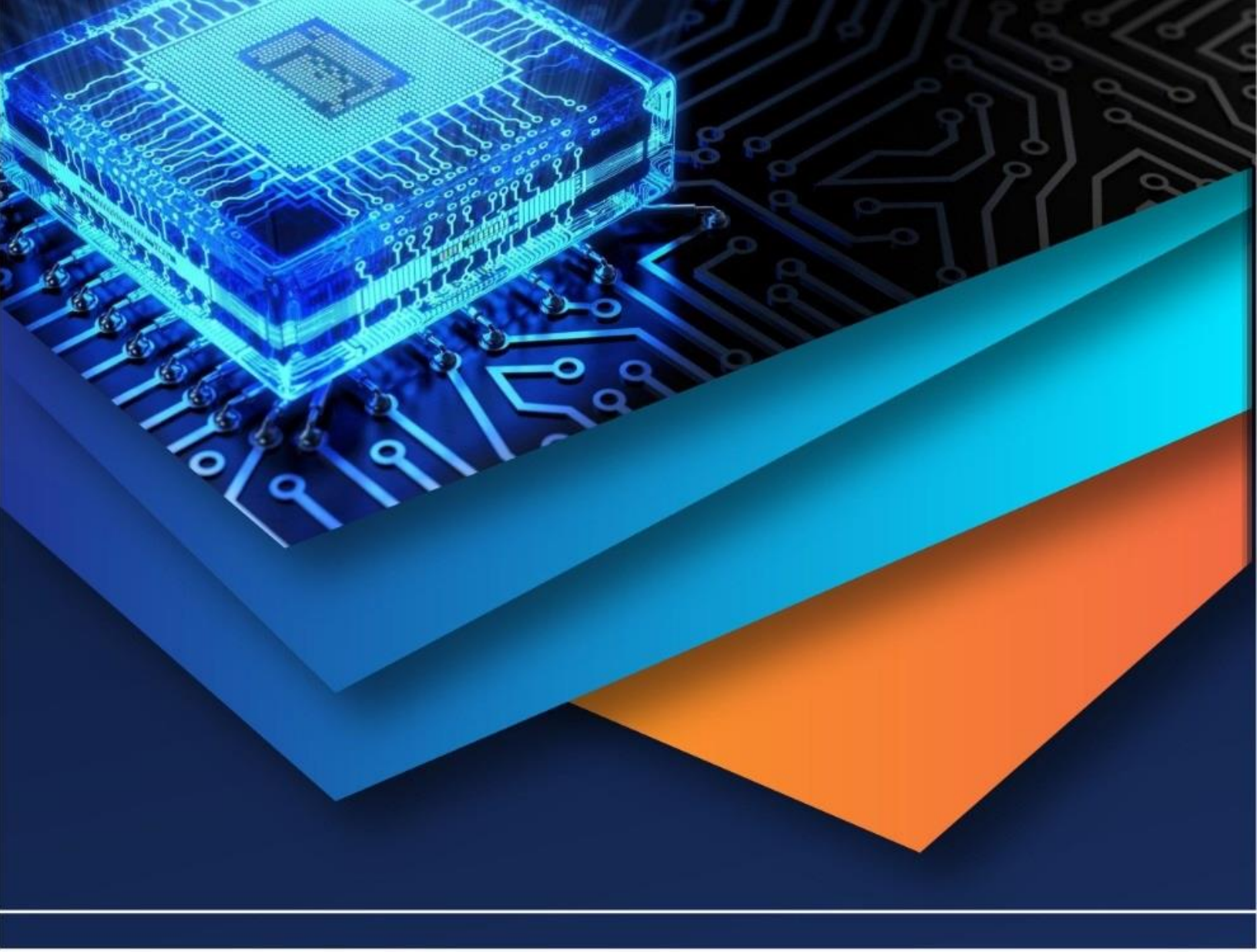
[1]Data are expressed as mean ± Standard Deviation

Critical Difference: Treatment (A) = 0.003, Temperature (B) = 0.003, Storage period (C) = 0.005 Factor A * B = 0.005, Factor A * C = 0.007, Factor A * C = 0.007, Factor A * B * C = 0.010

Table 7. Changes in the color of bottle gourd juice samples during storage

		Control (Refrigeration)	Treatment (Refrigeration)	Control (Room)	Treatment (Room)
0 days	R[1]	4.6	4.6	4.5	4.5
	Y[2]	55.9	55.9	57.4	56.8
	W[3]	0.3	0.3	0.3	0.3
5 days	R	4.5	4.4	4.2	4.3
	Y	52.4	52.4	52.4	52.4
	W	0.3	0.3	0.3	0.3
10 days	R	2.5	1.2	3.6	2.5
	Y	30.9	30.9	20.9	20.9
	W	0	0.1	0.5	0.1
15 days	R	3.4	2.4	2.4	2.4
	Y	37	38	29.4	26
	W	0.1	0.3	0.4	0.4

[1]R = RED [2]Y = YELLOW [3]W = WHITE



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