

## ***ALLIUM CEPA* L. VAR. *AGGREGATUM* DON – A TREASURE OF MICRONUTRIENTS AND NON-STRUCTURAL CARBOHYDRATES**

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### **Abstract**

The study was conducted with four aggregatum onion *viz.*, Co (On) 5, Co (On) 6, Local Perambalur (LP) and Local Manachanalur (LM), varieties of Tamil Nadu, India. Selected micronutrients were analyzed in which, the LP variety was reported to be higher in Na, K, Ca, Zn, Mn, Mg and Se. Similarly, the highest folic acid ( $48.23 \pm 0.47$  mg/Kg) and pyruvic acid ( $3.02 \pm 0.02$   $\mu$ mole g<sup>-1</sup>) was observed in the same variety. Non-structural carbohydrates, fructose and sucrose were found higher ( $463.8 \pm 0.26$  and  $257.37 \pm 3.49$  mg/kg) in LP variety. However, LM variety is higher in glucose ( $1169.57 \pm 33.73$  mg/kg), galactose ( $234.4 \pm 0.62$  mg/kg) and maltose ( $227.2 \pm 1.44$  mg/kg). This study therefore, provides preliminary information on micronutrients and non-structural carbohydrates of selected aggregatum onion varieties of Tamil Nadu.

### **Introduction**

Aggregatum onion (*Allium cepa* L. var. *aggregatum* Don.) is one of the horticultural crops extensively grown and consumed in southern states of India, predominantly in Tamil Nadu. It is an indispensable bulb vegetable due to the presence of essential phytonutrients, which increases strong flavor and taste in food. It has high active nutrients which include proteins, carbohydrates, sugars, vitamins, minerals with certain flavonoids and polyphenols constituents (Sami *et al.* 2021). The phenolic acids reported in onion are ellagic, caffeic, sinapic and p-coumaric acids. It also has sterols, saponins, and volatile oils. Moreover, the bioactive compounds in onion have anti-inflammatory, antioxidant, anti-obesity, anti-diabetic, anticancer, anti-allergic, cardiovascular protective, neuroprotective, respiratory protective and bacteriostatic properties (Taglienti *et al.* 2021).

About 65 to 80% of the onion bulb dry matter consists of nonstructural carbohydrates (NSC). It determines the nutritional values of onion bulb. Consequently, NSC is either directly or indirectly involved in all plant functional processes of primary and secondary metabolisms. Some of the functions of NSC are defense, osmoprotection, osmoregulation and it is tightly linked to photosynthesis and respiration (Hartmann and Trumbore 2016).

The aim of this study is to evaluate the micronutrients and NSC present in the selected aggregatum onion varieties of Tamil Nadu. These aggregatum onion varieties have not yet been explored by the scientific community. Thus, results of this study will give the clear visualization about the nutritional aspects of aggregatum onion and the baseline studies will be helpful in future research.

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### Materials and Methods

The LP, LM, Co (On) 5 and Co (On) 6 aggregatum onion samples were collected from the different farmers' field at Perambalur district, Tamil Nadu, by following proper sampling procedures. The collected samples were dried and deep frozen with liquid nitrogen. Further, pounded with mortar and pestle. The powder was used for mineral profiling, vitamin analysis and NSC quantification. Different minerals were analyzed in onion samples with the help of atomic absorption spectrophotometer (Lindsay and Norvell 1978) and flame photometer (Piper 1966). Acid digestion technique was used to estimate these minerals. Selenium was analyzed using suitable procedures defined in AOAC (2019) using ICP OES.

One gram of onion sample was homogenized with 5 ml of 100% methanol. It was centrifuged and filtered. Then the samples were injected in HPLC system for the quantification of NSC and folic acid. An HPLC system (Agilent 1260 Infinity II series, USA) armed with UV RID detector, was used for the quantification and identification of NSC in the onion samples. The obtained chromatogram was assessed with the help of retention time of the samples against the standard (Ng and Reuter 2015). An HPLC system (Agilent 1260 Infinity II Series, USA) armed with a quaternary pump, a degasser, a thermostatic auto-sampler and a UV DAD detector, was used for quantification and identification of folic acid content in the onion samples. The obtained chromatogram was assessed for the presence of folic acid with the help of retention time of the samples against the folic acid standard ((El-Leithy *et al.* 2018).

The ascorbic acid content was determined by the 2,6-dichlorophenol indophenol (DCPIP) titration procedure (Sadasivam and Balasubramanian 1987). Pyruvic acid was analyzed by DNPH method with slight modifications (Abayomi *et al.* 2006). The calibration curve was made by preparing pyruvic acid solutions at concentrations of 0.04-0.4 mmol/L in water and the pyruvic acid concentration were expressed in terms of ( $\mu\text{mol/g}$  fresh weight (FW) aliquot. The data were expressed as  $\mu\text{mol}$  of PA/g FW.

All the analysis was carried out in triplicate and the results are presented as mean  $\pm$  standard deviation on dry weight basis. The data was subjected to one way analysis of variance (ANOVA) with Duncan's Multiple Range Test (DMRT) using SPSS statistics (version 26).

### Results and Discussion

Aggregatum onion contains abundance of sodium in all the four varieties ranging from  $200.00 \pm 5.49$  to  $274.50 \pm 7.17$  mg/kg. The highest level of potassium was observed in LP and lowest was recorded in Co (On) 5 with the concentration of  $168.50 \pm 2.73$  and  $81.10 \pm 3.16$  mg/kg. Calcium in selected onion varieties was ranged from  $79.86 \pm 1.51$  to  $85.05 \pm 1.53$  mg/kg. The LP variety was found to have the highest selenium content ( $150.60 \pm 6.38$  mg/kg). However, the trace elements like Zn, Cu and Mn were present in negligible quantities ( $0.20 \pm 0.01$ ,  $0.20 \pm 0.00$ ,  $0.22 \pm 0.00$  mg/kg respectively (Table 1). Table 1 also shows the RDA for various minerals (Vasudevan *et al.* 2019).

A sugar profile (Fructose, Glucose, Galactose, Sucrose and Maltose) of selected onion varieties were presented in Table 2. In all onion samples, fructose was eluted first, with retention time of 5.97 minutes (LM and LP), 5.92 minutes (Co (On) 6), and 5.98 minutes (Co (On) 5). Glucose, galactose, sucrose, and maltose were eluted with retention time of 7.05, 7.58, 8.16 and 9.12 min in Co (On) 6. The retention time for LP and LM were 7.06 and 7.05, 7.61 and 7.63, 8.53 and 8.52, and 9.14 and 9.13 minutes, respectively. In Co (On) 5, the retention time were 7.05, 7.61, 8.19, and 9.12 minutes. The results were shown in Fig 1.

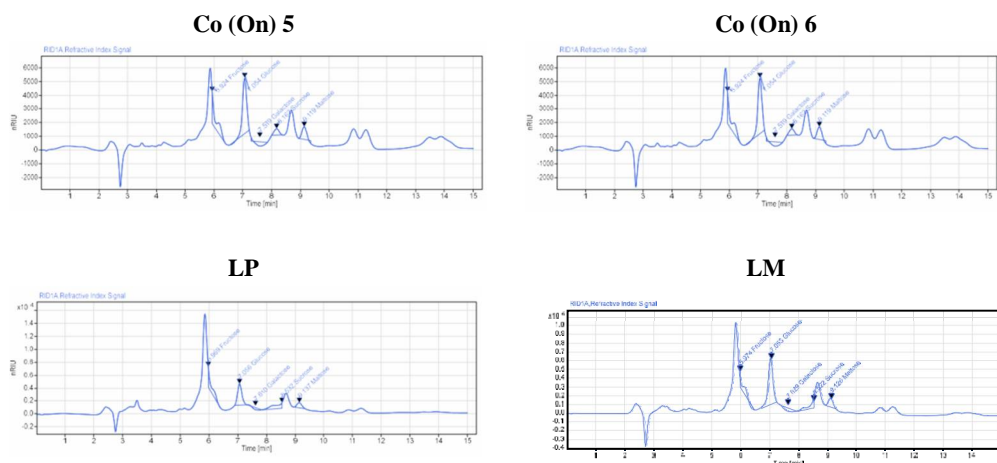
In LP, sucrose and fructose were found to be in higher concentration ( $257.37 \pm 3.49$  mg/kg and  $463.8 \pm 0.26$ , respectively) than the other varieties. In the case of LM, the highest

concentration of glucose ( $1169.57 \pm 33.73$  mg/ kg), galactose ( $234.4 \pm 0.62$  mg/ kg) and maltose ( $227.2 \pm 1.44$  mg/kg) were reported. The Co (On) 5 and Co (On) 6 have the lowest concentration of NSC compared to LP and LM (Table 2).

**Table 1. Mineral profile of four aggregatum onion varieties.**

Minerals	Co (On) 5 (mg/kg)	Co (On) 6 (mg/kg)	LP (mg/kg)	LM (mg/kg)	RDA* (per day)
Na	$200.00 \pm 5.49^c$	$205.80 \pm 6.30^c$	$*274.50 \pm 7.17^a$	$237.01 \pm 5.12^b$	5-10 g
K	$81.10 \pm 3.16^c$	$79.04 \pm 1.78^c$	$*168.50 \pm 2.73^a$	$131.10 \pm 0.59^b$	3-4 g
Ca	$85.05 \pm 1.53^a$	$79.86 \pm 1.51^b$	$*87.52 \pm 2.36^a$	$85.50 \pm 1.92^a$	500-1500 mg
Fe	$8.09 \pm 0.23^b$	$*19.90 \pm 0.61^a$	$5.14 \pm 0.18^d$	$6.84 \pm 0.17^c$	15-20 mg
Zn	$0.14 \pm 0.00^b$	$0.10 \pm 0.00^d$	$*0.20 \pm 0.01^a$	$0.12 \pm 0.00^c$	5-20 mg
Cu	$0.15 \pm 0.00^d$	$*0.22 \pm 0.00^a$	$0.20 \pm 0.00^c$	$0.21 \pm 0.00^b$	1.5-3 mg
Mn	$0.11 \pm 0.00^d$	$0.13 \pm 0.00^c$	$*0.22 \pm 0.00^a$	$0.15 \pm 0.00^b$	5 mg
Mg	$3.85 \pm 0.12^a$	$3.88 \pm 0.16^a$	$*3.95 \pm 0.03^a$	$3.72 \pm 0.14^a$	400 mg
Se	$142.80 \pm 0.29^b$	$45.30 \pm 1.38^d$	$*150.60 \pm 6.38^a$	$141.00 \pm 3.81^b$	50-100 µg

Means in each column followed by the same letter were not significantly at  $P < 0.05$ . Values were the means of three replications  $\pm$  standard deviation. \*Highest value of each mineral content.



**Fig. 1. Sugar profile of four aggregatum onion by UHPLC.**

The quantification of folic acid in Co (On) 5, Co (On) 6, LP and LM onion samples is presented in the Table 3 and the chromatograms of the samples tested are depicted in Fig. 2. In this study, a sharp, well resolved and proportioned peak was detected for the onion samples with the retention time of 3.11 min at 290 nm with the peak height of 21.517, 21.808, 49.30 and 25.682, respectively. The folic acid content of four aggregatum varieties was ranged from 25.857 to 48.233 mg/kg. Highest folic acid content was recorded by the LP variety ( $48.23 \pm 0.47$  mg/kg) followed by LM ( $32.04 \pm 1.38$  mg/kg), Co (On) 5 ( $27.64 \pm 0.95$ mg/kg) and Co (On) 6 ( $25.85 \pm 0.67$  mg/kg). Saraswathi *et al.* (2017) have reviewed the nutritional values of aggregatum onion and reported the amount of folic acid in aggregatum onion was 34 µg/100 g.

The vitamin C content of the onion is showed in Table 3. It ranges from  $8.15 \pm 0.01$  mg/100 g to  $9.31 \pm 0.30$  mg/100 g. All most all the four onion varieties were exhibited the good amount of vitamin C, in which Co (On) 6 recorded the highest  $9.31 \pm 0.30$  mg/100 g. Similar studies were reported by Armand *et al.* (2018) who studied the vitamin C content in three onion varieties in which they observed the vitamin C contents varied from 3.26 mg/100 g to 45.07 mg/100 g dry matter.

**Table 2. Non-structural carbohydrate (NSC) profile of four onion varieties.**

Variety	Fructose mg/kg	Glucose mg/kg	Galactose mg/kg	Sucrose mg/kg	Maltose mg/kg
Co (On) 5	$325.63 \pm 4.83^c$	$1129.87 \pm 29.51^a$	$184.57 \pm 5.00^a$	$27.6 \pm 0.62^c$	$160.7 \pm 3.60^c$
Co (On) 6	$394.47 \pm 2.73^b$	$828.47 \pm 17.19^b$	$141.1 \pm 3.34^b$	$49.9 \pm 1.53^b$	$195.1 \pm 5.76^a$
LP	$463.8 \pm 0.26^a$	$682.57 \pm 14.17^c$	$75.1 \pm 2.16^c$	$257.37 \pm 3.49^a$	$180.43 \pm 3.09^b$
LM	$311.4 \pm 6.48^d$	$1169.57 \pm 33.73^a$	$234.4 \pm 0.62^a$	$68.43 \pm 2.10^b$	$227.2 \pm 1.44^a$
S.E. (M)	2.46	14.45	1.85	1.27	2.19
C.D.(P=0.05)	8.17	47.85	6.14	4.21	7.27

Means in each column followed by the same letter were not significantly different at  $P < 0.05$ . Values were the means of three replications  $\pm$  standard deviation.

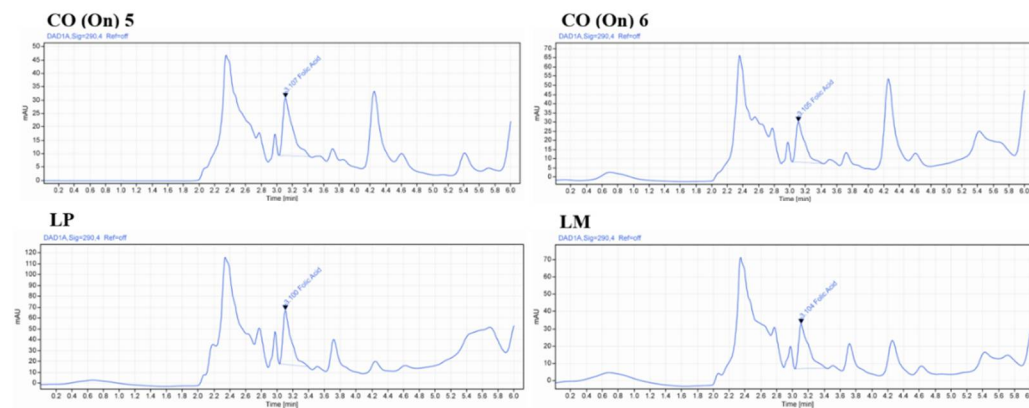


Fig. 2. Folic acid profile of four aggregatum onion by UHPLC.

**Table 3. Vitamin profile of four aggregatum onion varieties.**

Vitamins	Co (On) 5	Co (On) 6	LP	LM	RDA
Folic acid (mg/kg)	$27.64 \pm 0.95^c$	$25.85 \pm 0.67^d$	$*48.23 \pm 0.47^a$	$32.04 \pm 1.38^b$	200 $\mu$ g
Ascorbic acid (mg/100 g)	$8.81 \pm 0.27^b$	$*9.31 \pm 0.30^a$	$8.15 \pm 0.01^d$	$8.52 \pm 0.18^{bc}$	75 mg
Pyruvic acid ( $\mu$ mole/g)	$2.86 \pm 0.62^{bc}$	$2.93 \pm 0.01^{ab}$	$*3.02 \pm 0.02^c$	$2.77 \pm 0.08^a$	-

Means in each column followed by the same letter were not significantly different at  $P < 0.05$ . Values were the means of three replications  $\pm$  standard deviation. \*Highest value of each vitamin content.

The pungency of aggregatum onion is specified in the Table 3. The pyruvic acid content is ranged from  $2.77 \pm 0.08$  to  $3.02 \pm 0.02$   $\mu\text{mole/g}$ . All the four varieties are on par with the pungency character of the aggregatum onion. As per the pungency classification, the selected onions in this study are classified under low pungency ( $0-3$   $\mu\text{mol}$  pyruvic acid/g FW). Recently, consumer demand has been oriented toward onion cultivars with low pungency. Hence, the selected onion varieties are showing good consumer preferences in Tamil Nadu.

Onion is nutritious and contains mixture of bioactive compounds. This study focuses on the exploration of micronutrients and NSC in the aggregatum onion varieties of Tamil Nadu, India. Among the four varieties, LP exhibited the good amount of micronutrients and found to be highly nutritive. The onion varieties with low pyruvic acid are less pungent and are desirable character for consumers. The amount of NSC varies in different varieties which is due to the difference in the rate of metabolic activities during germination.

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