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Qualitative and Quantitative Phytochemical Screening of Male Flower Buds of Some Banana Cultivars Grown in Assam

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Authors' contributions

This work was carried out in collaboration among all authors. Author HD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors DNH and SL managed the analyses of the study. Author RB managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted in the Department of Horticulture, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali in the period begning from November, 2016 till the end of 2018 with eight different banana cultivars grown in Assam *i.e* T_1: Jahaji (AAA), T_2: Amritsagar (AAA), T_3: Chenichampa (AAB), T_4: Malbhog (AAB), T_5: Kachkal (ABB), T_6: Manohar (ABB), T_7: Bhimkal (BBB), T_8: Wild banana (BB). Phytochemical assessment revealed the highest and lowest values of p^H in the cultivars of *balbisiana* group and *acuminata* group, respectively. The moisture content ranged from 80 to 90 percent; ash content, sucrose content, crude fibre and total carbohydrate content varied in all the cultivars. Sugar content in terms of glucose and fructose were highest in Chenichampa while the lowest glucose content was recorded in Amritsagar. Phosphorus content ranged from 51.98 mg/100g to 14.27 mg/100g while potassium content ranged from 786.40 mg/100g to 427.61 mg/100g. The male flower buds possessed crude protein, starch, anthocyanin, sugars, carbohydrates, proteins, important minerals like phosphorus, potassium, sodium, calcium, magnesium, zinc, iron and anti-nutrients like tannin, saponin and phenolic compounds, but their

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concentrations varied among the cultivars. Organoleptic taste revealed that the male flower buds of cultivars namely, Bhimkal (BB), Wild banana (BB), Malbhog (AAB) and Kachkal (ABB) were found to be tastiest for consumption as vegetable.

Keywords: Banana; Musa acuminate; Musa balbisiana; male bud; phytochemicals.

1. INTRODUCTION

Musa, a plant genus of extraordinary to human societies, produces the fourth most important food in the world today after rice, wheat and maize. *Musa species* grows in a wide range of environments and have varied human uses, ranging from the edible bananas and plantains of the tropics to cold-hardy fiber and ornamental plants. The word "banana" is a general term embracing a number of species or hybrids in the genus *Musa* of the family Musaceae. Almost all of the known edible cultivars of banana arose from two diploid species, *Musa acuminata* (AA) and *Musa balbisiana* (BB). Dessert bananas for world food trade are almost entirely derived from genetic makeup of *Musa acuminata* of triploid character, indicated as AAA. Plantain and other bananas that can be used for cooking (cooking bananas, *Musa* ABB) are also triploid and derived from hybridization between *Musa acuminata* (AA) and *Musa balbisiana* (BB).

Banana provides food security, nutrition and income for many small holder farmers. In the world, 145 million tons of banana are produced of which 16.5 million tonnes are traded internationally [1]. India is the largest producer of banana in the world with a production of 29,162.55 thousand MT from an area of 858.10 thousand hectares while area and production of banana in Assam are 55.42 thousand hectares and 979.34 thousand MT, respectively during 2016-17 with the productivity of 17.56 MT/ha as compared to the national productivity of 33.98 t/ha [1]. The major banana growing states in India are Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Madhya Pradesh, Bihar, Uttar Pradesh, West Bengal and Assam.

Though banana occupies a major part of routine diet, banana male flower bud is also considered as a vegetable and is cooked in a variety of dishes in Asian countries like curry, deep fried, cutlet etc. Besides cooked dishes, banana flower bud is also used to treat some diseases. In China, the flower is used to treat heart pain, asthma and endocrine problem like diabetes. Consumption of banana flowers helps to treat diarrhea and stomach cramps. Banana male flower bud carries different nutrients and vitamins in considerable amount and is also used for infantile malnutrition and weak body. But the male buds of all the cultivated species are not suitable for consumption. The reason behind this is the presence of anti-nutrients like tannin, saponin, phenolic compounds and many more in varying concentrations. The concentrations of these in the male flower bud define the suitability of consumption of the male bud. Generally, the male bud of bananas belonging to *balbisiana* group of species are more suitable for consumption as they are lack of these anti-nutrients or due to presence of negligible amount of these anti-nutrients. The most of the bananas belonging to *accuminata* group of species are not suitable for consumption due to bitterness which is because of the high concentration of those anti-nutrients.

In Assam, people add male flower bud in their cooking recipe as a very nutritious food. Common banana cultivars cultivated in Assam are Jahaji (AAA), Barjahaji (AAA), Amritsagar (AAA), Red banana (AAA), Malbhog (AAB), Chenichampa (AAB), Manohar (ABB), Hundakal (AAB), Kachkal (ABB), Bhimkal (BB), etc. Wild banana (BB) grows naturally in the hill slopes of Assam, the fruits of which are highly seeded. Among the different cultivars, male flower buds of Bhimkal, Malbhog and wild banana are widely used as vegetable while the male flower buds of other cultivars are not preferred by the consumers though male flower buds of all the cultivated cultivars are sold in the markets of Assam. Though researches on biochemical analysis of male flower buds of some prominent cultivars have been done but the systematic study of biochemical analysis of male buds of commercial cultivars of Assam has not yet taken up

Keeping in view the existing situation, an attempt has been made to study the morphological and phytochemical properties of banana male flower buds of eight cultivars viz., Jahaji (AAA), Amritsagar (AAA), Chenichampa (AAB), Malbhog (AAB), Kachkal (ABB), Manohar (ABB), Bhimkal (BB) and wild banana (BB) were taken with the following objective :

Qualitative and quantitative phytochemical screening of male flower buds of banana cultivars grown in Assam.

2. MATERIALS AND METHODS

Phytochemical assessment of male flower buds of banana was done by drying the samples. For the purpose, the mature bracts of male flower buds were removed and remaining portion was grated with the help of a grater to assess the proximate compositions like pH, moisture content, ash, total carbohydrate, anthocyanin, crude protein, crude fibre and starch, sugars mainly glucose, fructose and sucrose, minerals like calcium, magnesium, zinc, potassium, iron, phosphorus and sodium, anti-nutrients like tannin, saponin and phenolic compounds. Moisture content, pH, ash content, calcium, magnesium, iron and phosphorus were estimated by using the method given by Saini et. al [2]. Satrch and total carbohydrate content were estimated by anthrone method given by Hedge and Hofreiter [3]. Total phenolic compounds and glucose were estimated by the method given by Malik and Singh [4]. Potasium and sodium content were estimated by the method given by Ward and Johnson [5]. The content of crude protein [6], crude fibre [7], anthocyanin content [8], zinc [9], fructose content [10], sucrose [11], tannin [12] and saponin content [13] were also estimated following the standard methods.

The data recorded were statistically analyzed adopting the procedure of analysis of variance by Completely Randomized Design (CRD). Significance or non-significance of the variance due to treatments were determined by calculating the respective 'F' values by following the method described by Panse and Sukhatme [14]. The significance of difference between mean values of character of treatment was tested by computing Least Significance Difference (LSD) estimates.

3. RESULTS AND DISCUSSION

The results of the important nutrients like crude fibre, crude protein, total carbohydrate and starch including p^H, moisture content and ash content showed variation in all the male flower buds of the different cultivars. The p^H was highest in Wild banana (5.7) and lowest in Jahaji (4.8). In the present findings, p^H gradually increased from T_1 (Jahaji) to T_8 (Wild banana) which revealed that p^H of male flower buds of cultivars i.e. Jahaji and Amritsagar with AAA genomic group was lower than the cultivars with AAB, ABB and BB genomic groups.

The ash content is a measure of the total amount of minerals or inorganic components present in a food such as Ca, Na and K. Ash is the organic residue remaining after the water and organic matter have been removed by heating in the presence of oxidizing agents. In the present study, Jahaji (AAA), and Amritsagar (AAA) recorded higher ash contents than the other cultivars. Higher ash contents in the cultivars might be due to the genetic constituents of the cultivars with more strain of *acuminata* than that of the cultivars of *balbisiana*. The present finding is in conformity with the results of Sew [15].

Crude fibre is a class mineral that is continuous filaments or are ion discrete elongated pieces, similar to lengths of thread. A higher content of fibres in banana flowers indicates that the flowers may be consumed as dietary fibre supplements [15]. Crude fibre content of flowers of Jahaji was higher while the lowest content of fibre was found in Wild banana which might be due to differences in genomic constituents.

Total carbohydrate content in this study was lower than the average found in other studies because dried samples were used for laboratory analysis. The total carbohydrate contents varied from 1383.18 mg/100g (Manohar, ABB) to 3727.37 mg/100g (Jahaji, AAA) and showed a significant difference between the various cultivars with different genomic groups. The difference could be explained not only by varietal diversification within the same genomic group but also by the difference in the various zones of cultivation [16]. This might be the reason of variations in total carbohydrate contents of banana flowers of different cultivars as the male flower buds were collected from different parts of Assam for the study. Similar results and justifications were also reported by Akubor and Ishiwu [17].

The results of the present study revealed that there were significant differences in starch and crude protein. Both these phytochemical contents were found to be highest in Wild banana. Sheng et al. [16], justified that this variation could be attributed to different genotypes. All the variations found in the study were in conformity with Fingolo et al [18].

Anthocyanin is one of the important components of bracts of male flower buds of banana which

influences the variations in bract colour. The significant variation in anthocyanin content was observed in the present study which was determined by analysing the dried composite samples of banana flowers and immature bracts. The lower levels of anthocyanin in the present study might be due to the use of immature bracts edible portion to estimate the contents of anthocyanin. It was reported earlier by Simmonds [19] that the proportions of the various components were slightly variable in between the clones of one species and even between samples, but the general pattern was characteristic of a species and was therefore of considerable taxonomic value. In *Musa acuminata* a decline in bract colour is related to variation in oxidation and methylation of the anthocyanidins. According to Harrmann [20], the concentration of phytochemicals markedly drops from the outer to the inner parts of the male flower buds.

Sugars like glucose, fructose and sucrose are also an important nutritional component found in male flower buds of the banana. During the assessment of the sugars, the values of glucose, fructose and sucrose showed a significant difference between the cultivars. Chenichampa (AAB) had the highest content of glucose (8064.52 mg/100g) and fructose (20795.59 mg/100g) while the lowest glucose (1729.49 mg/100g) and fructose (4919.41 mg/100g) were recorded in Amritsagar (AAA) and Manohar (ABB), respectively. Bhimkal (BB) recorded the highest sucrose content (2172.22 mg/100g) and the lowest (628.93 mg/100g) was found in Kachkal (ABB). Happi Emaga et al [21], suggested that the sugar level could vary with the various cultivars even within the same genomic group. The results are in accordance with the result obtained by Florenta et al [22].

The present study showed a significant difference in mineral compositions of the male flower buds of different cultivars. The most abundant minerals found in banana flower were potassium followed by calcium and iron. The results revealed that a wide variation was observed in the quantitative composition of minerals in flowers of different banana cultivars. According to Sheng et al [16], this could be due to their growing environmental conditions and genetic variations of each cultivar. The result of the present investigation gets support from the research of Fingolo et al [18].

In the study, banana male flower buds of eight cultivars gave the positive tests for tannins, saponin and total phenolics. Therefore, the presence of valuable phytochemical constituents revealed that banana flowers of these eight cultivars have health benefits to humans. Anti-nutrients were present in all the cultivars but in different concentrations. The concentration of the anti-nutrients directly influences the taste of the male flower bud and the blackening of colour of the food. In this study, Jahaji (AAA) had highest concentration of tannin (149.08 mg/100 g) and total phenolic compounds (113.83 mg/100 g) while, the tannin content was found to be the lowest (80.51 mg/100 g) in Manohar (ABB). Bhimkal (BB) recorded the lowest (43.88 mg/100 g) total phenolic compounds followed by 60.19 mg/100g in wild banana (BB). Saponin content was highest (1.78%) in Amritsagar (AAA) and lowest (0.11%) in Wild banana (BB). This result is in accordance with the results obtained by Mahmood et al [23] and Marikkar et al [24].

Table 1. Proximate compositions of male flower buds (p^H, moisture, ash content and total carbohydrate)

Treatments	p^H	Moisture content (%)	Ash content (mg/100g)	Total carbohydrate (mg/100g)
T_1: Jahaji (AAA)	4.8	89.04	5173.12	3727.37
T_2: Amritsagar (AAA)	5.2	90.59	3130.39	2786.02
T_3: Chenichampa (AAB)	5.3	89.34	3170.15	4041.17
T_4: Malbog (AAB)	5.3	89.06	3705.01	2251.14
T_5: Kachkal (ABB)	5.4	89.54	5106.56	3488.61
T_6: Manohar (ABB)	5.3	89.55	5444.45	1383.18
T_7: Bhimkal (BB)	5.4	88.95	4474.88	1825.39
T_8: Wild banana (BB)	5.7	90.16	3748.50	2529.95
LSD (P=0.05)	0.31	0.04	62.38	138.05

Table 2 Proximate compositions of male flower buds (Crude protein, crude fibre, starch and anthocyanin)

Treatments	Crude protein (%)	Crude fibre (%)	Starch (mg/100g)	Anthocyanin (mg/100g)
T_1: Jahaji (AAA)	14.32	9.56	19.72	4.14
T_2: Amritsagar (AAA)	14.70	8.39	9.38	1.88
T_3: Chenichampa (AAB)	11.85	4.75	23.91	1.18
T_4: Malbog (AAB)	12.05	4.17	10.36	0.84
T_5: Kachkal (ABB)	9.92	8.19	8.33	1.30
T_6: Manohar (ABB)	10.12	7.35	15.60	0.16
T_7: Bhimkal (BB)	13.96	8.09	10.95	2.82
T_8: Wild banana (BB)	14.71	4.51	28.23	2.32
LSD (P=0.05)	0.70	2.58	0.70	0.04

Table 3. Sugar compositions of male flower buds

Treatments	Glucose (mg/100g)	Fructose (mg/100g)	Sucrose (mg/100g)
T_1: Jahaji (AAA)	3684.59	17792.04	1167.03
T_2: Amritsagar (AAA)	1729.49	9481.42	6491.15
T_3: Chenichampa (AAB)	8064.52	20795.59	813.54
T_4: Malbog (AAB)	6001.79	5859.66	1342.17
T_5: Kachkal (ABB)	5307.18	14558.64	628.93
T_6: Manohar (ABB)	2340.76	4919.41	2152.89
T_7: Bhimkal (BB)	6251.59	12446.24	2172.22
T_8: Wild banana (BB)	5713.27	12433.26	1183.24
LSD (P=0.05)	142.31	330.61	350.47

Table 4 Mineral compositions (calcium, magnesium, zinc) of male flower buds

Treatments	Calcium (mg/100g)	Magnesium (mg/100g)	Zinc (mg/100g)
T_1: Jahaji (AAA)	197.64	37.02	6.91
T_2: Amritsagar (AAA)	214.54	33.90	7.19
T_3: Chenichampa (AAB)	246.37	20.62	4.03
T_4: Malbog (AAB)	274.22	28.58	3.33
T_5: Kachkal (ABB)	187.05	32.00	6.08
T_6: Manohar (ABB)	275.53	33.42	4.42
T_7: Bhimkal (BB)	207.92	20.38	4.53
T_8: Wild banana (BB)	214.62	24.35	4.19
LSD (P=0.05)	5.77	3.89	0.77

Table 5. Mineral compositions (potassium, iron, phosphorus and sodium) of male flower buds

Treatments	Potassium (mg/100g)	Iron (mg/100g)	Phosphorus (mg/100g)	Sodium (mg/100g)
T_1: Jahaji (AAA)	786.40	212.88	41.11	9.35
T_2: Amritsagar (AAA)	571.44	189.44	38.90	32.78
T_3: Chenichampa (AAB)	698.11	200.49	41.98	8.29
T_4: Malbog (AAB)	604.04	183.51	36.84	9.10
T_5: Kachkal (ABB)	670.60	182.20	33.19	29.27
T_6: Manohar (ABB)	721.00	182.09	37.19	8.13
T_7: Bhimkal (BB)	655.21	194.97	51.98	12.08
T_8: Wild banana (BB)	427.61	208.14	14.27	13.71
LSD (P=0.05)	52.67	11.25	9.01	8.06

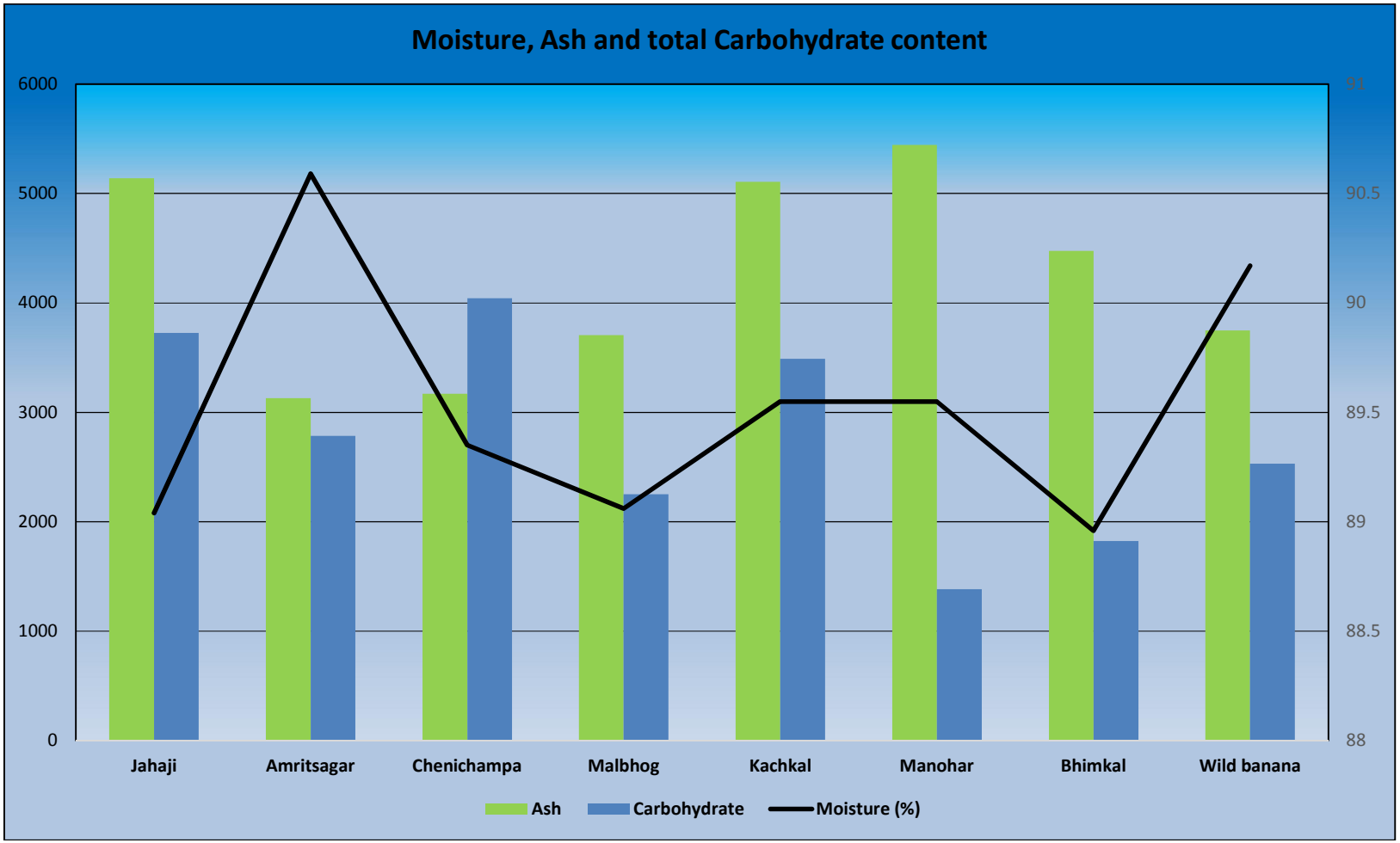

Fig. 1a. Proximate compositions (ash, carbohydrate and moisture content) of male flower buds

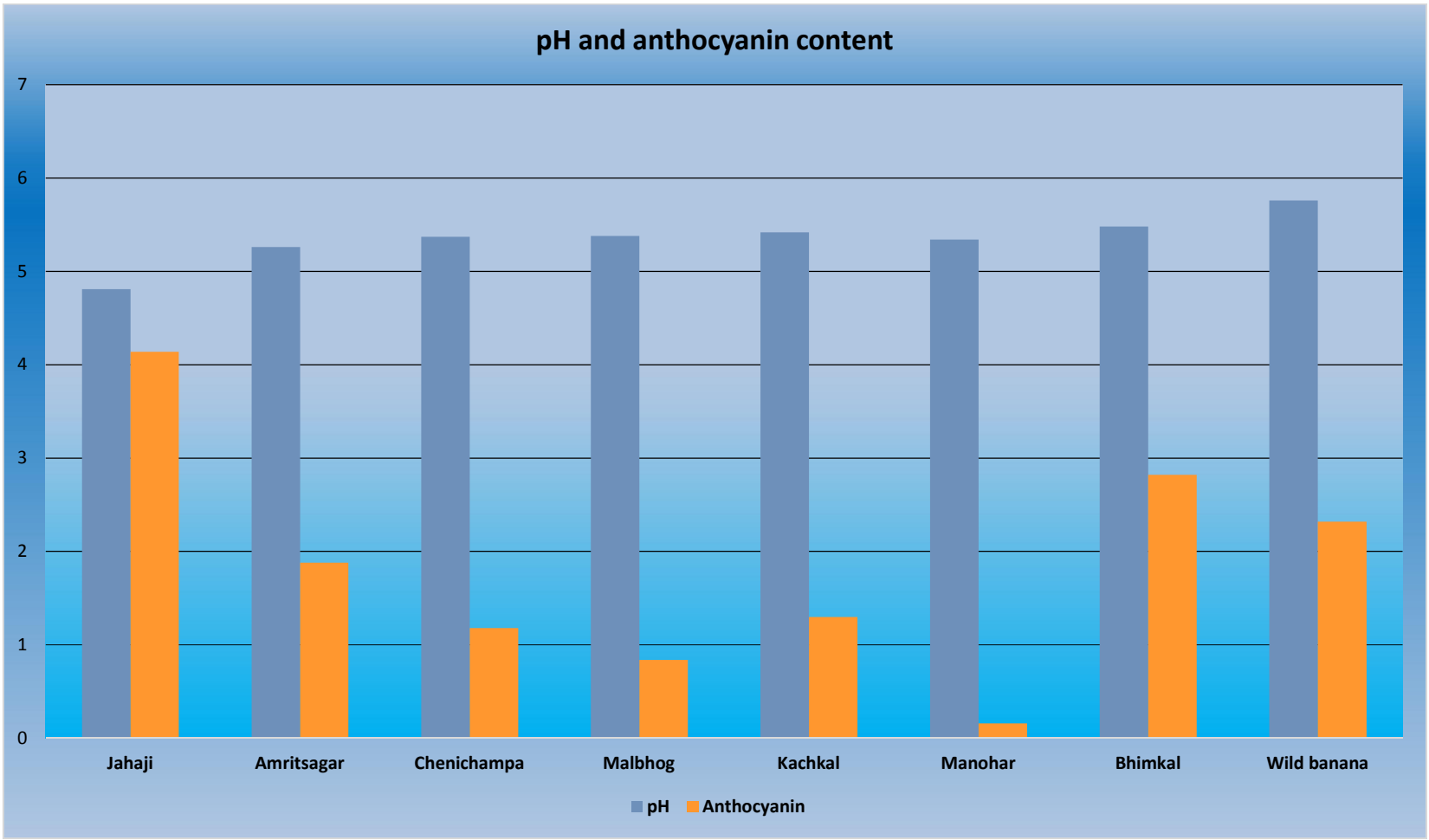

Fig. 1b. Proximate compositions (p^H and anthocyanin) of male flower buds

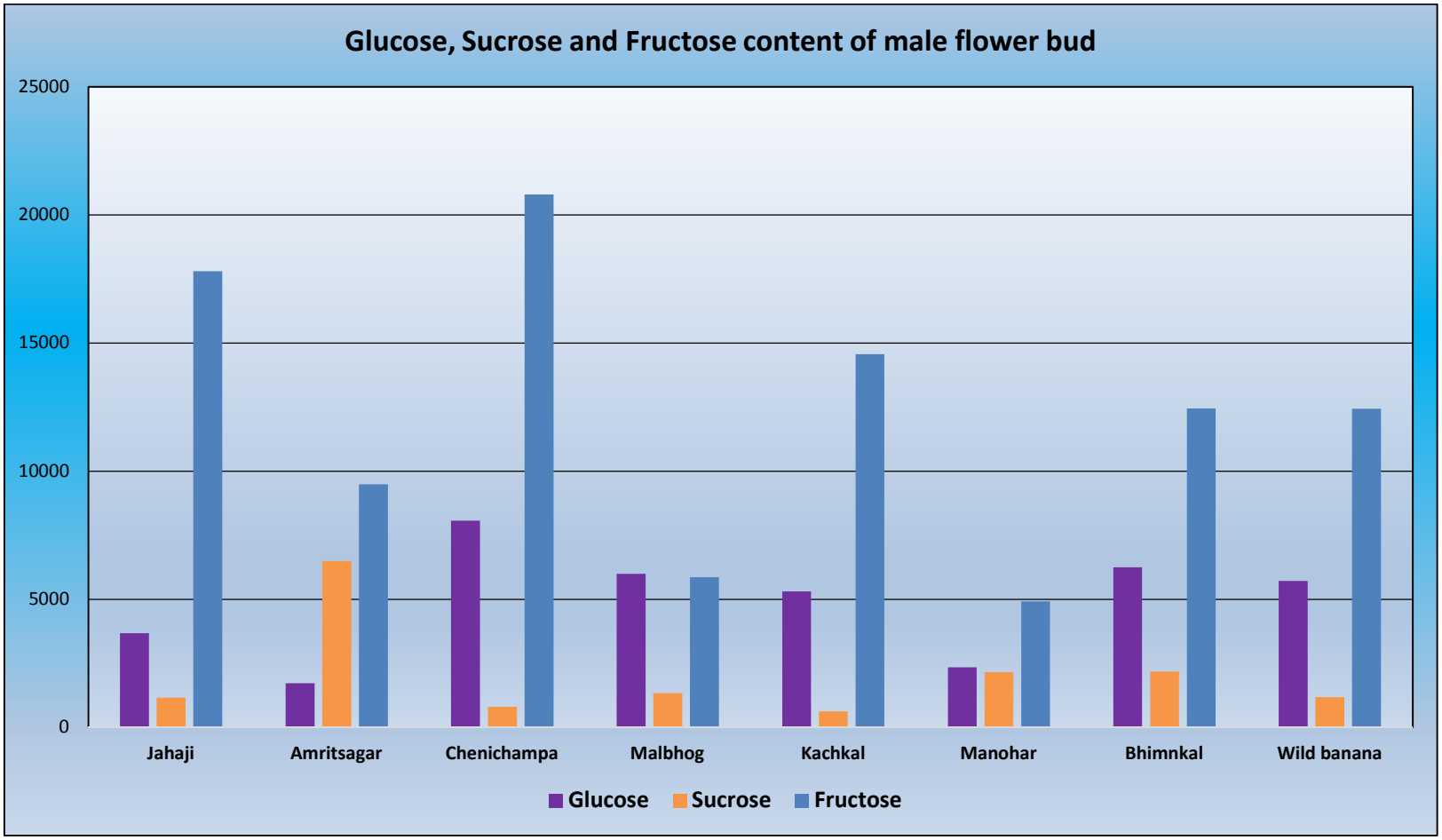

Fig. 2. Sugar compositions of male flower bud

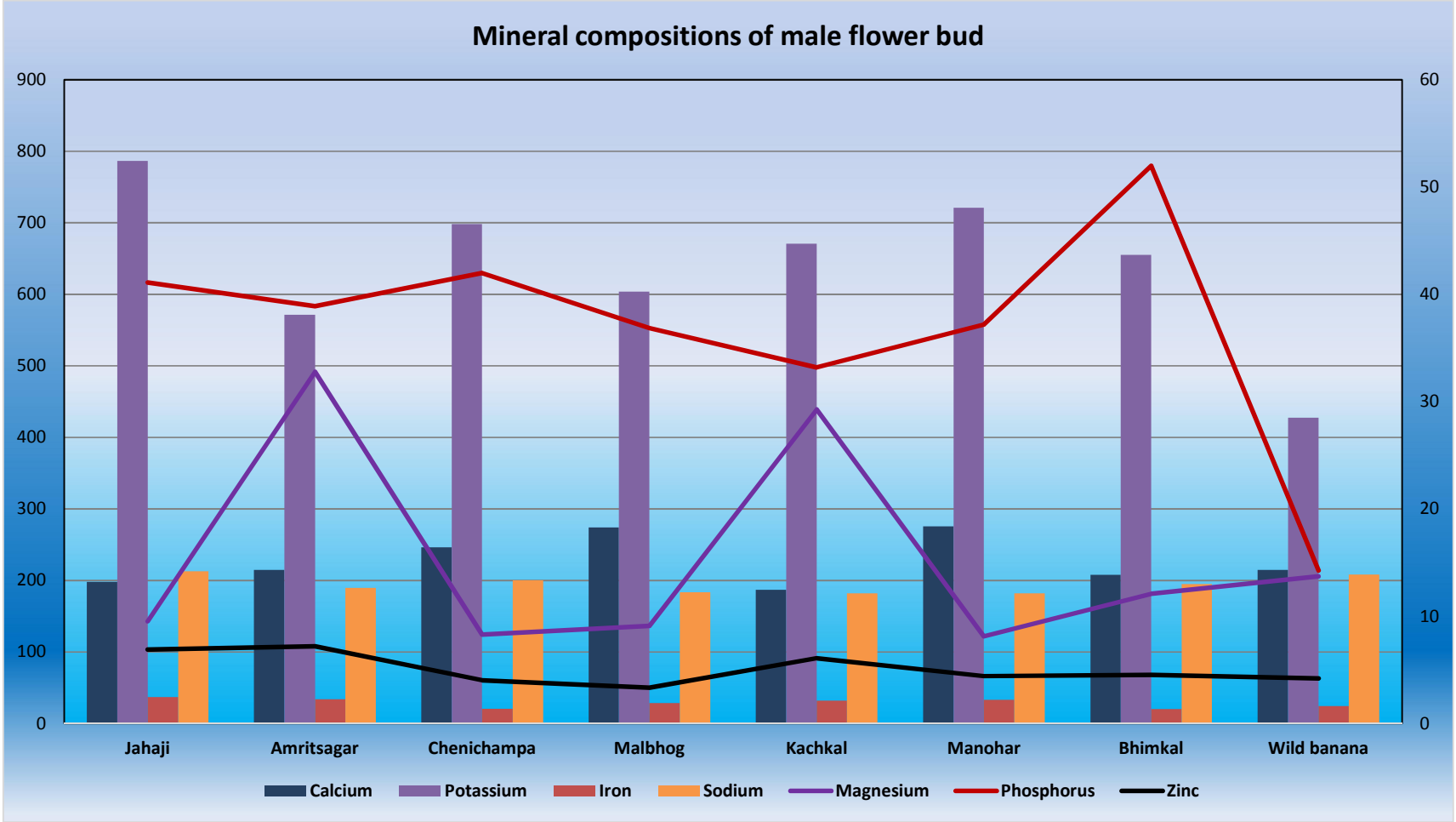

Fig. 3. Mineral compositions of male flower buds

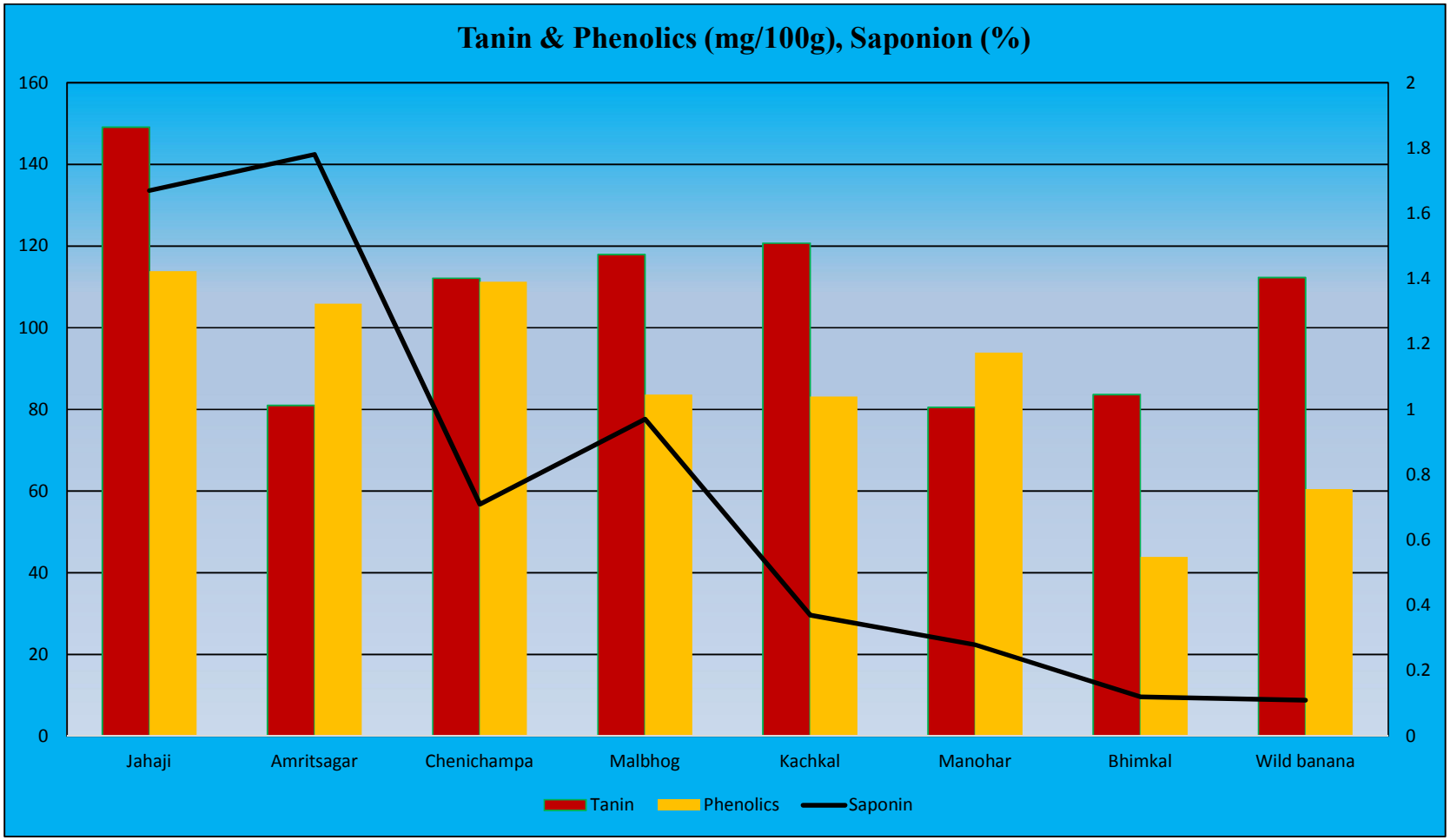

Fig. 4. Anti-nutrient compositions of male flower buds

4. CONCLUSION

Phytochemical constituents of male flower buds varied among the cultivars. Due to the presence of higher phenolic compounds, the male flower buds of Jahaji and Amritsagar, the taste become bitter and not suitable for consumption.

Considering the rich contents of carbohydrates, protein, fibre, minerals and sugar contents, the male flower buds of Bhimkal, Wild banana, Malbhog and Manohar might be considered as one of the major vegetables.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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