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Individual weights and unit counts for major fruits, vegetables and flowers

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Abstract

This research is done to get an understanding about the weight of different vegetables, fruits and flowers, this can be useful when shopping, when managing food intake or it can just be fun to learn. These measurements can be very useful when preparing food and make calculations much easier when you already have a base for the unit weight of certain vegetables, fruit and flowers. Fruit and vegetables are healthy alternatives to other processed foods, but weighing them can still help maintain a balanced diet. Not only in the kitchen, but also in the shop, these scales can make it easier to find the perfect number and quantity. Anything too much can be unhealthy. Hence, having knowledge on weights of fruits, vegetables and flowers help you find balance in buying, consuming and also marketing them.

Keywords: Fruits, vegetables, flowers, individual weight, counts per unit

Introduction

The test weight is an important indicator of yield and also a genetic quality of the cultivar of a crop. It is an important phenomenon as it largely influences the total output from a unit area of land. It is a parameter that decides the seed rate or quantity required to produce the optimum population of a crop under cultivation. In agricultural crops the test weight is a very important measure of seed quality, which is effective on sprouting, seed potential, seedling growth, and plant performance (Hossein Afshari *et al.,* 2011) [4] and this quality is reliant on the embryo size and stored nutrients used for germination and growth (Ebadi and Hisoriev, 2011; Cao *et al.*, 2011) [2, 3]. In farm based industries, the use of test weight in grains is important for determining grain values (Carl Bern and Thomas, 2009) [6]. There is a popular belief that if test weight is high then it will also yield high but the fact is there is very little correlation between high test weight and high yields (). In agricultural crops, crop yields depend on crop establishment, choice of seed; optimum plant population, spacing and plant geometry, method and time of sowing are the factors that Nielsen, 2014 [5] influence the crop growth and yield (Deivasigamani and Swaminathan,2018) [1].

For horticultural crops, the unit weight of fruit, vegetables and flowers is a key metric which has a direct impact on yield forecasts, harvesting efficiency, automated sorting and market viability. It is the primary indicator of plant health, nutrient intake and growth efficiency, and consumers associate optimum weight and larger sizes with freshness, quality and flavour. Moreover, uniform weights make packaging more efficient, minimise transit damage and ensure fair retail prices, while aligning production with strict global supply chain standards. While agronomic cereal crops such as maize and soya rely on the weight of the bulk test--which is highest on the first drying day after harvest at a specific moisture content--horticultural products use different physical metrics such as individual unit weights, specific gravity, volume density and biomass of the tissue. Tropical fruits such as mangoes and avocados, for example, use specific gravity as a non-destructive index of oil content and internal ripeness, which allows for efficient sorting in the flotation tanks. Vegetable metrics differ according to the type of plant, leafy greens are valued for their compactness and firmness of the head, while tomatoes and potatoes require a high specific gravity to indicate a high starch content and a higher rate of recovery in the industrial process. In contrast, floriculture does not take volume weight into account at all, but focuses instead on the biomass of the stems and the stability of the bud to ensure proper hydration and prolong the life of the vase. In the end, understanding these different weight metrics is essential for researchers, farmers and consumers, which is why a specific study has been carried out on selected horticultural crops. In the case of agricultural crops, the maximum test weight is reached when the grain is harvested on the first drying day and also at a higher ideal moisture content of 16-19 percent for soybeans and maize and 20-25 percent for maize. (Robert Kratochvil, 2016) [7].

Today, all farm produce are sold by weight, including coconuts, melons, cabbage, cauliflowers, etc. It is of the utmost importance that the consumer/buyer has knowledge of the average weight per unit of fruit or vegetable when purchasing the product. The aim of this study is to raise awareness among consumers, researchers and the public of the weight of individual horticultural products, in particular vegetables, flowers and fruits and we have taken samples from the central markets and carried out systemic scientific analyses to determine the unit weight of these crops and also presented the produce number in a unit weight of produce. It will facilitate easy buying also.

Materials and Methods

Location of the experiment

The study was conducted at Agronomy Lab, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai- 625104, Tamil Nadu during 2024-25. The samples for fruits were collected from Kodai road Fruits Market and fruit shops situated in Othakadai fruit stalls. The vegetable samples for the study were gathered from Oddanchatram Vegetable Market, Dindigul, Tamil Nadu, which is one of the biggest vegetable markets in India. The flower samples were collected from Madurai Mattuthavani Flower Market and also from Usilampatti Flower Market in Madurai district.

Methodology

To determine test weight of fruits, in each fruit 200 samples were taken and were weighed in a calibrated scientific digital balance. Each fruit was weighed individually and number fruits contained in a kilogram of weight was counted. For bigger sized fruits like watermelon, which are more than 1 kg weight, single fruit weight was taken and then we calculated mean value. The same pattern followed for vegetables also. For the determination of the physical characteristics of the flowers, 50 samples of one hundred flowers each were randomly selected from each species and weighed to record the average weight. Twenty independent samples of 250 grams each were taken for each species in order to estimate the total number of flowers per kilogram. The individual flowers of these 250-gram samples were carefully counted and the final figures extrapolated to determine the total number of flowers per kilogram.

Statistical analysis

To determine accurate value, The mean and standard error were analysed and presented in tables as mean $\pm$ Standard error using EXCEL. The standard error of the mean, indicates how different the population mean is likely to be from a sample mean. It tells you how much the sample mean would vary if you were to repeat a study using new samples from within a single population.

SE= standard error of the sample

σ = sample standard deviation

n = number of samples

$$SE = \frac{\sigma}{\sqrt{n}} \quad \sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{n-1}}$$

Results and Discussion

The taxonomical classification and phenology of the fruits studied are presented below in table (1) along with the mean data and standard error. It implies the various fruit attributes of different types of fruit species studied.

The data on evaluation fruits revealed three different fruit availability profiles, i.e. permanent, highly seasonal and dual seasonal. Papaya is the only true perennial crop offering fruit production and availability year round. The remainder shows a close correlation between the season and the environment. The summer fruits (mango, watermelon, melon, pineapple) predominate in the warm months from February to July. The winter fruit (pomegranates, mandarins) ripens from October to January. Notably, guavas and pears have a dual seasonal flow, maximizing market presence.

Table 1: Taxa, phenology and physical traits of fruit parameters of selected fruit species

Sl.no	Name	Botanical name	Family	Fruits availability season	Fruit yield in t/ha	Fruit yield kg/tree	Mean weight of one fruit (kg) ± S.E.	No. of fruits in a kg
1	Mango	*Mangifera indica*	Anacardiaceae	March to June	15 to 20	0.15-0.5	0.440 ± 0.0159 (Imam Pasand) 0.313 ± 0.0179 (Sappatai)	2-3 (Imam Pasand) 3-4 (Sappatai)
2	Pomegranate	*Punica granatum*	Punicaceae	October-January	10 to 25	0.2 -0.3	0.2285 ± 0.0099	4
3	Apple	*Malus domestic*	Rosaceae		20 to 50	10 – 20	0.1670 ± 0.0036	6
4	Pear	*Pyrus communis*	Rosaceae	May-June July-October	15 to 30	100-120	0.1545 ± 0.0006	6
5	Guava	*Psidium gujava*	Myrtaceae	February- July September-January	25	0.1 -0.5	0.2385± 0.0014	4
6	Sathukudi (Sweet Orange)	*Citrus sinensis*	Rutaceae	August-October	30	0.15-0.25	0.1695 ± 0.009	6
7	Mandarin orange	*Citrus reticulata blanco*	Rutaceae	November-December	30	0.06-0.08	0.2815 ± 0.0334	3-4
8	Water melon	*Citrullus lanatus*	Cucurbitaceae	February-July	80 to 90	5-8	3.7885 ± 0.2546	-
9	Musk melon	*Cucumis melo*	Cucurbitaceae	April-August	20	0.8-1.0	1.2295 ± 0.0841	-
10	Pine apple	*Ananas sativus*	Bromeliaceae	March-June	50	0.15 – 0.25	1.2230 ± 0.0144	-
11	Papaya	*Carica papaya*	Caricaceae	All months	200 to 250	0.4-0.6	1.2885 ± 0.0558	-
12	Dragon fruit	*Selenicer eusundatus*	Cactacea	June-November	12 to 18	0.35-0.70	0.3915 ± 0.0086	2-3

The thirteen fruit types that were evaluated differed significantly in terms of their mean single fruit weight and the corresponding number of units per kilogram. With an individual mean weight of 3.7885 ± 0.2546 kg, watermelon was the heaviest fruit sampled. Followed by this, papaya (1.2885 ± 0.0558 kg), musk melon (1.2295 ± 0.0841 kg), and pineapple (1.2230 ± 0.0144 kg) comprised an exclusive group of large fruits with mean weights bigger than 1.0 kg. A single unit of these large fruits exceeds a standard one-kilogram threshold due to their high individual mass, making it impossible to determine a standard count per kilogram count. Conversely, the smallest mean individual weight was, however, the pear at 0.1545 ± 0.0006 kg, followed closely by the sweet orange (0.1695 ± 0.0090 kg) and the apple (0.1670 ± 0.0036 kg). Consequently, these smaller fruit types produced exactly six fruits per kilogram and showed the highest packing density in commercial circulation. With individual fruit weights ranging from 0.2285 kg to 0.4400 kg, medium-sized fruits were found to be in the middle of the range. Mango also falls into that category. The weight of pomegranate was also the lowest (0.2285 ± 0.0099 kg, with only 4 fruits per kg), as was the weight of mango cv. Imampasand weighed the heaviest (0.440 kg ± 0.0159 kg with 2-3 kg of fruit per kg).

A highly uniform size distribution appropriate for standardized retail packaging is highlighted by the close clustering of counts for pear, sweet orange, and apple (exactly 6 fruits/kg). Phenotypic and intra-species differences between commodities are most noticeable in the medium weight class. Pomegranate has a low standard error indicates either synchronized crop maturity or strict grading procedures. The significant influence of genetic factors on crop yield metrics is highlighted by the clear difference between the two mango cultivars. Compared to Imampasand's mean weight was significantly higher. Sappatai, creating a distinct tier system for market pricing and sorting. The standard errors in both Mango CVs were comparatively higher as both cultivars such as Sappatai and Imam Pasand might be explained by the distinctive fruiting genetics of these particular cultivars, natural variation in canopy positioning, or fruit thinning techniques.

The taxonomical classification and phenology of the vegetables studied are presented below in table (2) along with the mean data and standard error. It implies the various physical attributes of different types of vegetables studied.

Table 2: Taxa, yield potential and physical traits of selected vegetables

Sl.no	Name	Scientific name	Family	Yield	No. of vegetables in a kilogram	Weight of a single unit (g)
1	Ash gourd	*Benincasa hispida (Thunb.) Cogn*	Cucurbitaceae	20 t/ha	-	1.65
2	Beet root	*Beta vulgaris L.*	Chenopodiaceae	20-25 t/ha	7.63 ± 0.465*	131
3	Bhendi	*Abelmoschus esculentus (L) Moench*	Malvaceae	12 - 15 t/ha	73.20 ± 4.300	13.7
4	Bitter gourd	*Momordica charantia L.*	Cucurbitaceae	14-15 t/ha	11.40 ± 0.748	87.7
5	Bottle gourd	*Lagenaria siceraria (Mol) Standl*	Cucurbitaceae	15 - 20 t/ha	2.0 ± 0.239	0.52
6	Brinjal	*Solanum melongena L.*	Solanaceae	25 to 30 t/ha	30.40 ± 2.380	32.9
7	Cabbage	*Brassica oleracea var. capitata*	Brassicaceae	70 – 80 t/ha	1.25±± 0.067	0.81
8	Carrot	*Daucus carota L*	Umbelliferae	25 – 30 t/ha	13.30 ± 0.840	75.2
9	Cauliflower	*Brassica oleracea var. botrytis*	Brassicaceae	15 – 20 t/ha	1.2±0.054	0.87
10	Chilli	*Capsicum annuum L.*	Solanaceae	10 - 15 t/ha of green chillies.	228.40 ± 4.470	4.4
11	Chow-chow	*Sechium edule*	Cucurbitaceae	25 - 35 t/ha	4.20 ± 0.373	238.1
12	Drumstick	*Moringa oleifera L.*	Moringaceae	50 - 55t/ha pods. (220 pods/tree/year)	10.70 ± 0.662	93.5
13	Elephant foot yam	*Amorphophallus campanulatus*	Araceae	30 - 35 t/ha	1.1 ± 0.184	0.96
14	French Beans	*Phaseolus vulgaris L*	Fabaceae	8 - 10 t/ha	214.60 ± 7.370*	4.7
15	Garden lablab	*Lablab purpureus*	Fabaceae	2.5-5.0 t/ha of green pods	129.60 ± 4.750	7.7
16	Onion Bellary	*Allium cepa var. cepa*	Alliaceae	15 – 18 t/ha	20.0 ± 1.300	50.0
17	Onion small	*Allium cepa var. aggregatum*	Alliaceae	15 - 18 t/ha	58.80 ± 2.760	17.0
18	Plantain	*Musa spp*	Musaceae	25-35 t/ha	8.80 ± 0.730	113.6
19	Potato	*Solanum tuberosum* L.	Solanaceae	15 – 20 t/ha	8.30 ± 0.870	120.5
20	Pumpkin	*Cucurbita moschata* Poir	Cucurbitaceae	18-20 t/ha	-	3.56
21	Radish	*Raphanus sativus L*	Brassicaceae	20 – 30 t/ha	7.70 ± 0.525	129.9
22	Tomato	*Solanum lycopersicon Mill*	Solanaceae	30 - 40 t / ha	64.40 ± 2.330 (local) 12.40 + 0.400 (hybrid)	15.5 (local) 80.6 (hybrid)
23	Yam	*Dioscorea esculentus*	Dioscoreacea	20 – 25 t/ha	46.60 ± 2.770	21.5

*standard error

The per hectare yield potential of all the vegetables studied are given in table (3). The data on the individual weight of vegetables show a broad range of physical observations (table 4), including larger vegetables such as chow-chow (231 g) and smaller vegetables such as chilli (4.4 g) and beans (4.7 g). The assessment of weight variations reveals different patterns of phenotypic uniformity and commercial classification. Potatoes and chow-chow show the highest variation, while chillies and tomatoes show low variation, indicating either a strict sorting or a very homogeneous genetic development. Similar development differences are observed between Bellary onions (50.0 g) and small onions (17.0 g), underlining functional differences in dry matter accumulation and crop usefulness. Intermediate mesobiotic vegetables such as drumsticks (93.5 g) and carrots (75.2 g) are well-balanced commercial cultivars that fall within a predictable range of physical extremes.

These dimensional differences dictate the key physiological post-harvest behaviours and logistics management strategies. Lighter weight vegetables such as Bhendi (13.7 g), garden lablab (7.7 g), beans and chillies have a high cumulative area-to-weight ratio per kilogram, which makes them acutely vulnerable to rapid loss of fresh weight and moisture in the cold chain, which requires strict control of the moisture level. In contrast, heavier vegetables such as beetroot (131.1 g) and radish (129.9 g) have minimal exposed surfaces but generate high localized pressure. The individual weight of vegetable influences the number of units contained in a unit weight of vegetables. This requires packaging materials with higher mechanical and penetrating strength to avoid compression bruising during bulk transportation.

The taxonomical classification and phenology of the flowers studied are presented below in table (3) along with the mean data and standard error. It implies the various physical attributes of different types of flowers studied.

Table 3: Taxa, yield potential of selected flowers

Sl.no	Name	Scientific name	Family	Available season	Yield	Mean weight of 100 flowers	No. of flowers in a kilogram
1	Jasmine	*Jasminum sambac*	Oleaceae	Summer	8.0 to 9.0 t/ha	20.40 ± 0.13	4400-5390
2	Pitchi / Mullai	*Jasminum Grandiflorum/ J.auriculatum*	Oleaceae	Summer	4.4 to 10.0 t ha	20.40 ± 0.14	4560-5490
3	Kanagambaram (crossandra)	*Crossandra infundibuliformis*	Acanthaceae	Spring, Summer Fall	2.0 t/ha	20.18 ± 0.16	4460-5450
4	Marigold	*Calendula officinalis*	Asteraceae	summer Fall	10-18 t/ha	19.18 ± 0.58*	4690- 5730
5	Tube Rose	*Polianthes tuberosa*	Asparagaceae		14-15 t/ha	20.66 ± 0.03	4350-5320
6	Chrysanthemum	*Dendranthema grandiflora*	Asteraceae	September to December	10-11 t/acre	19.60 ± 0.32	4590-5610
7	Nerium	*Nerium oleander*	Apocynaceae	April to August	25.0 to 30.0 t/ha	19.99 ± 0.32 (pink) 20.35 ± 0.12 (White)	4500-5500 (pink) 4420-5410 (White)
8	Rosa hybrida	*Rosa hybrida*	Rosaceae	May to December	30 tons/acre	20.15 ± 0.12 (Damask rose) 19.71 ± 0.36 (Red button rose)	4470-5460 (Damask rose) 4560-5580 (Red button rose)

Experimental data provide a comprehensive comparative analysis of the single flower characteristics, which reveal a consistent relationship between the weight of individual flowers and the total number of flowers contained in one kilogram. This one kilogram threshold is a factor that has a direct impact on the commercial packing and yield metrics. The tube rose had the highest average weight of one hundred flowers at 20.66 ± 0.03 grams, resulting in the lowest number of flowers per kilogram, which ranged from 4350 to 5320 flowers, owing to its higher individual density. Conversely, Marigold had the lowest average weight of 19.18 ± 0.58 grams, requiring the highest number of flowers per kilogram, which ranged from 4690 to 5,730 flowers.

Marigold also showed a natural variation in flower size during the harvesting period. Jasmine and mullai had the same average weight of 20.40 grams per 100 flowers, but mullai showed a slightly wider numerical range in terms of total number of flowers/ kg compared to Jasmine, indicating a higher degree of structural or moisture variation. Within the same genus, pigmentation also correlated with physical weight changes, with white Nerium showing a mean weight of 20.35 ± 0.12 grams compared to 19.99 ± 0.32 grams for pink Nerium indicating that a lower number of flowers are enough to weigh a kilogram. The flower crops such as Crossandra and Damask rose have a very stable biomass distribution in the medium range with a close grouping of flowers, indicating a consistent development and predictable commercial characteristics for these species.

Most commercial fruit has a generally round or round shape, and their physical size and total volume may vary considerably. The individual weight of fruit, vegetables and flowers is determined primarily by the genetic composition of the cultivars. Within a particular variety, the unit weight of a single unit usually shows a minimum variation.

Conclusion

In an age of rapid technology advancement, the main goal of research is to simplify complex problems and make innovative solutions available for broad public adoption. As a first step towards this objective, the study measured the average weight of common fruits, vegetables and flowers to make everyday health and cooking practices more efficient. In the area of nutrition, the manual weighing of produce for each meal is highly impractical; the establishment of reliable reference weights allows individuals to estimate portion sizes visually and to maintain their dietary plans accurately. As overconsumption can lead to adverse health effects, the use of these standardized weight measurements is an effective tool to maintain dietary balance while also facilitating consumer choices in food purchasing, meal planning and daily cooking.

Statements and Declarations

Authors Contributions (CReDit): CS conceptualized, supervised and monitored the whole study and wrote and improved the manuscript. AS recorded biometrics and assisted in data analysis and editing the manuscript. CS

Conflicts of interest statement: The authors declare that they do not have any conflicts of interest.

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