

Sensory Analysis for Consumer Acceptance and Juice Extraction Yield of Wheatgrass, Barley grass and Oat Grass Juices

Arbenita Hasani Rexhepi*, Renata Kongoli

Faculty of Biotechnology and Food; Agricultural University of Tirana.

Tirana, Albania. www.ubt.edu.al

*Corresponding email: arbenitahasani@gmail.com

Abstract:- Green juices containing grain grasses such as wheatgrass, barley grass, oat grass and alpha alpha grass are considered nowadays novel functional foods, super food or specific food, because of their high content of health promoting nutrition's such as antioxidants, polyphenols, chlorophyll, amino acids, minerals, vitamins, active enzymes and other nutrients.

The study evaluated sensory characteristics and consumer acceptance of green juices extracted from wheatgrass, barley grass and oat grass, as well as their formulations with apple juice. The sensory tests were carried out with 19 non-trained panelists using a structured 5-point hedonic scale. Data collected by the evaluation forms was processed using Statistical Regression and Descriptive Analysis to obtain important statistical values such as the average acceptance-means, standard deviations, coefficients of variation, correlation analysis for each analyzed organoleptic characteristic, as well as the overall mean acceptance and standard error of each sample. The juices involved in this research were also assessed for pH, Total Soluble Content °Brix, Titrable acidity, and sugar/acid ratio because of their direct interference in sensory attributes of juices.

Key words: green juice, sensory evaluation, novel food, functional food.

I. INTRODUCTION

Nowadays, there is increased consumer demand for high-antioxidant foods. Drinking high-antioxidant beverages may help to protect against aging, Alzheimer's disease, and other chronic diseases [1]. Cereal grasses (young shoots of grain-bearing plants) including alfalfa, barley grass, wheatgrass are one such type of Green foods which are very beneficial for a healthy body [2]. Such nutrient-rich green juices are bursting with goodness, from their essential vitamins and minerals to phyto-nutrients that are rarely found in other foods in such high concentrations. In order to benefit from the healing and nutritive properties of wheatgrass, barley grass and oat grass, the body must be able to absorb vital nutrients. Humans cannot digest cellulose or fiber, so grass juices are the best way to get crucial nutrients into human bodies. Considering their high values of health promoting phyto-chemicals and very rich nutritional values of green juices as well as considering that green juices containing grasses are an innovation in juice industry, it was of crucial importance to conduct a study with the goal of evaluating the sensory attributes for consumer acceptance of these products, as well as the juice extraction yield for cost calculations and decision making on their commercial potential.

A. Wheat Grass

The Wheat Grass refers to the young grass of the common wheat plant, *Triticum aestivum* that is freshly juiced or dried into powder for animal and human consumption. Both provide chlorophyll, amino acids, minerals, vitamins, and enzymes. Wheat grass is a humble weed that is a powerhouse of nutrients and vitamins for the human body. In the form of fresh juice, it has high concentrations of chlorophyll, active enzymes, vitamins and other nutrients [3], "fifteen pounds of wheatgrass is equal in overall nutritional value to 350 pounds of ordinary garden vegetables" [4].

Wheatgrass is proven to have high antioxidant activity. Antioxidant activity of the wheatgrass juice was compared with the standard drug ascorbic acid. From the graph of percent inhibition and IC50, it shows that wheatgrass juice is having significant antioxidant activity that is comparable to the standard drug ascorbic acid [5].

Wheatgrass juice is an integral part of the macrobiotic diet under the complementary and alternative medicine (CAM) approach of anticancer therapy, due to its high antioxidant content [6].

Comprehensive data from number of studies has revealed the multitude effects of wheatgrass in thalassemia, hemolytic anemia, cancer, asthma, allergy, inflammatory bowel disease and detoxification. The structural homology of chlorophyll with hemoglobin indicates the role of chlorophyll as a blood builder in various clinical conditions involving hemoglobin deficiency – thus the name “green blood”. To conclude, the wheatgrass seems to be a very promising herbal drug [7].

The pH (hydrogen molecules) value of both human blood and wheatgrass is about 7 (alkaline) and is therefore quickly absorbed in the blood and is highly beneficial. [3].

B. Barley Grass

The Barley grass can be defined as the young grass of the common barley plant *Hordeum vulgare*.

Health Benefits of Barley Grass - The Barley grass contains four times the amount of calcium as a glass of milk, and as much protein as one ounce of steak. It also has about twenty times more iron than spinach does and is rich in vitamins A, C, E, K, and B complex. It has every amino acid that human body requires and is great for those trying to lose weight or get a good night's sleep.

Since it has so many antioxidants, it helps in protection from numerous conditions, including cancer, heart disease, cognitive decline, and digestive issues. Finally, it helps protect against signs of aging and alkalizes the body so that your immune system functions well and diseases such as cancer are unable to thrive [8].

Same as wheatgrass, barley grass is also being marketed commercially as a super food, but between the two, wheatgrass is reported to contain a much higher level of vitamin E, selenium, phosphorus, manganese, chlorophyll, etc. (<http://juicing-for-health.com/basic-nutrition/healing-vegetables/health-benefits-of-wheatgrass-juice.html>).

C. Oatgrass

The Oat Grass for juicing is harvested at the peak of its life cycle, when the new growth of the grass is just about 14 days old. At this stage, the sun's energy has infused the delicate blades of grass with some of the most powerful weapons for full body healing.

The Oat Grass Juice is one of the richest sources of nutrients on the planet. It not only contains an abundance of amino acids, ones that are in ideal proportion for human consumption, it is also packed with critical vitamins, including B1, 2, 6, and 12. Oat Grass Juice is rich in minerals, vitamins, antioxidants, chlorophyll and also rich in enzymes. (<http://www.sunburstsuperfoods.com/organic-oat-grass-juice-powder/>).

The aim of this research is to:

- Identify the consumer acceptance of green juices.
- Between the three analyzed features to find out which one is most acceptable.
- What is the extraction yield of wheatgrass, barley grass and oat grass?

II. MATERIAL AND METHODS

Green juices extracted from Wheatgrass, Barley grass, Oat grass and commercial pasteurized 100% apple juice produced by MOEA/Frutomania LLC in Kravarice, town of Gjilan, Kosovo) were used in this research.

A. Juice extraction

Experimental land plots were planted with wheatgrass, barley grass and oat grass to be harvested on their so called jointing stage that means after the second leaf has grown as the half of the first leaf. Then, the grasses were cleaned and immediately juiced and stored on refrigerator at 7°C until the next day when the sensory analyses took place.

The juicing has been conducted by Fruit, Vegetable and Wheatgrass juicer Omega 8224 Nutrition Center Juicer, which is a masticating style juice extractor. Its ability to juice at low speeds – 80 RPM minimizes heat build-up and oxidation. The result is healthy fresh juice with the high enzyme content that health conscious individuals crave. Nutrition centers are engineered with powerful components that can easily extract juice from wheatgrass and leafy vegetables.

Juice extraction yield extracted with Omega 8224 Nutrition Center Juicer expressed by 1 juice/kg grass was for wheatgrass 0.7 l/kg, for barley grass was 0.6 l/kg and for oat grass 0.8 l/kg.

Formulations

Six formulations were prepared using wheatgrass juice, barley grass juice, oat grass juice and apple juice. Three analyzed samples were fresh extracted raw green juices from wheatgrass, barley grass and oat grass and the other three samples were the formulations of three above mentioned grass juices with the same concentration 70% of pasteurized 100% apple juice.

Table 1. Wheatgrass, barley grass, oat grass and apple juice formulations used in the research.

Sample code/material	Wheatgrass juice (%)	Barley grass juice (%)	Oat grass juice (%)	100% apple juice (%)
1	100	0	0	0
2	0	100	0	0
3	0	0	100	0
1A	30	0	0	70
2A	0	30	0	70
3A	0	0	30	70

B. Physical, physico-chemical and chemical analysis

The wheatgrass juice, barley grass juice, oat juice and their respective formulations with apple juice were analyzed for the pH (by using an electronic pH meter), Total Soluble solids (TSS) as °Brix (by using a hand refractometer) and Titrable acidity, according to AOAC (1995) [9]. To determine the sugar/acid ratio it was divided the sugar concentration (°Brix) by the % acid concentration.

C. Sensory analysis

A five 5 point structured hedonic evaluation test for acceptance was conducted with 19 non-trained panelists. The evaluation scale was 1= unacceptable - disliked extremely, 2 = bad - disliked moderately, 3 = average - neither liked nor disliked, 4 = Good - moderately liked, 5 = Excellent - extremely liked.

The panelists were asked to evaluate the following sensory attributes: Appearance/Color, aroma, intensity of aroma, taste, consistency and overall perception. The order of sample presentation was completely randomized for each panelist (Wakeling & MacFie, 1995).

The panelists were divided into two groups, first group of 10 panelists that evaluated samples from 1 to 3, and the second group of 9 panelists that evaluated samples 1A-3A.

Additional information concerning sex and age were asked at the end of the test in order to characterize the population sample.

D. Statistical analysis

The obtained primary data was then analyzed mainly by using Statistical Regression Analysis and Descriptive statistics. Descriptive statistics of the evaluation of organoleptic traits of wheatgrass, barley grass and oat grass juices (mean acceptance, standard deviation and coefficient of variation) were calculated by General Statistic Methods.

The test involved 19 panelists, 9 Male and 10 Female, aged 18-21. The reason for this young population involvement relies on the fact that all the panelist are students of the department of Food Technology and are selected since they have undergone some basic trainings on sensory evaluation during their coursework, although they are not professional degustators.

III. RESULTS AND DISCUSSIONS

A. The results obtained from physical, physico-chemical and chemical analyses are collected in the Table 2.

Table 2. pH, Total Soluble Solids (TSS), total titrable acidity (TTA), sugar/acid ratio values of the samples involved in this research:

Sample code/ analysis	Sample formulation	pH	TSS °Brix	TTA g/l malic acid	Acidity %	Sugar/acid ratio (°Brix /%acid)
1	Wheatgrass juice 100%	6.43	3.5	2.34	0.23	15.2
2	Barley grass juice 100%	6.04	3	1.40	0.14	21.4
3	Oat grass juice 100%	5.94	3.5	2.07	0.21	16.6
1A	Wheatgrass 30% & Apple juice 70%	3.52	9	2.01	0.20	45
2A	Barley grass juice 30% & Apple juice 70%	3.31	8.5	2.21	0.22	38,63
3A	Oat grass juice 30% & Apple juice 70%	3.51	9	2.07	0.21	42.85

The pH values of samples vary from the lowest pH 3.31 for sample 2A to 6.43 for sample Nr 1.

The TSS Values in Brix for grasses was 3-3.5 and for their respective formulations with apple juice 8.5-9.

TTA expressed in g/l Malic acid was the lowest for value 1.4 for sample No. 2 and the higher 2.34 for sample No.1. While the Sugar/Acid Ratio varies from 15.2 to 45 and it is the lowest for sample No. 1 and the highest for sample 1A.

Sensory Analyses

The average ratings, standard deviations, and coefficients of variation were initially calculated for all the panelists for each analyzed feature, including Appearance/Color, Aroma, Intensity of Aroma, Taste, Consistency, and Overall Perception. These values along with the mean acceptance, mean SD, and mean CV parameters are shown in following table.

Table.3 Average rating of analyzed features for all samples and Values of Mean Acceptance, mean Standard Deviation-SD and Coefficient of Variation for all samples involved in this test.

Sample/ Feature	Appearance/ Color	Aroma	Aroma intensity	Taste	Consistency	General Impression	Mean Acceptance	Mean SD	Mean CV
Sample 1	4.30	2.00	4.20	2.20	3.80	3.00	3.25	0.704	0.217
Sample 2	3.70	2.30	3.50	1.60	3.40	2.60	2.85	0.425	0.149
Sample 3	3.20	2.30	3.10	1.80	3.10	2.60	2.68	0.524	0.195
Sample 1A	3.22	1.44	3.11	1.67	2.67	2.22	2.39	0.68	0.285
Sample 2A	3.11	2.89	3.11	2.11	3.33	2.69	2.87	0.639	0.222
Sample 3A	2.89	3.33	3.56	3.22	3.11	3.90	3.20	0.439	0.137

Mean acceptance for sensory attributes of 6 samples varies from 2.39 to 3.25. The best ranged or best accepted by consumers was wheatgrass juice- sample 1 - with the mean value of acceptance 3.25, SD 0.704 and CV 0.217.

It is very interesting that the less accepted or ranged with mean value of acceptance 2.39, SD 0.68, and CV 0.285 was exactly the formulation with apple juice of the best ranged sample, wheatgrass juice.

The best ranged from all formulations of grass juices with apple juice was sample 3A, which is the formulation of Oat grass juice with apple juice, while the Oat grass juice alone (sample 3) showed to be least liked grass juice when tested as single juices.

Reason for this may be the chemical reaction and interaction between ingredients in the formulation and formation of new aroma profiles when in a formulation. Anyway, this may be considered as a signal for needed further research in this topic.

The mean Standard Deviation varies from minimal 0.425 for sample Nr. 3A to max. 0.704, while for the mean Coefficient of Variation we have a min of 0.137 and max 0.285.

The organoleptic evaluation for Appearance/Color, Aroma, Aroma intensity, Taste, Consistency, and General Impression for each sample is given by following graphic.

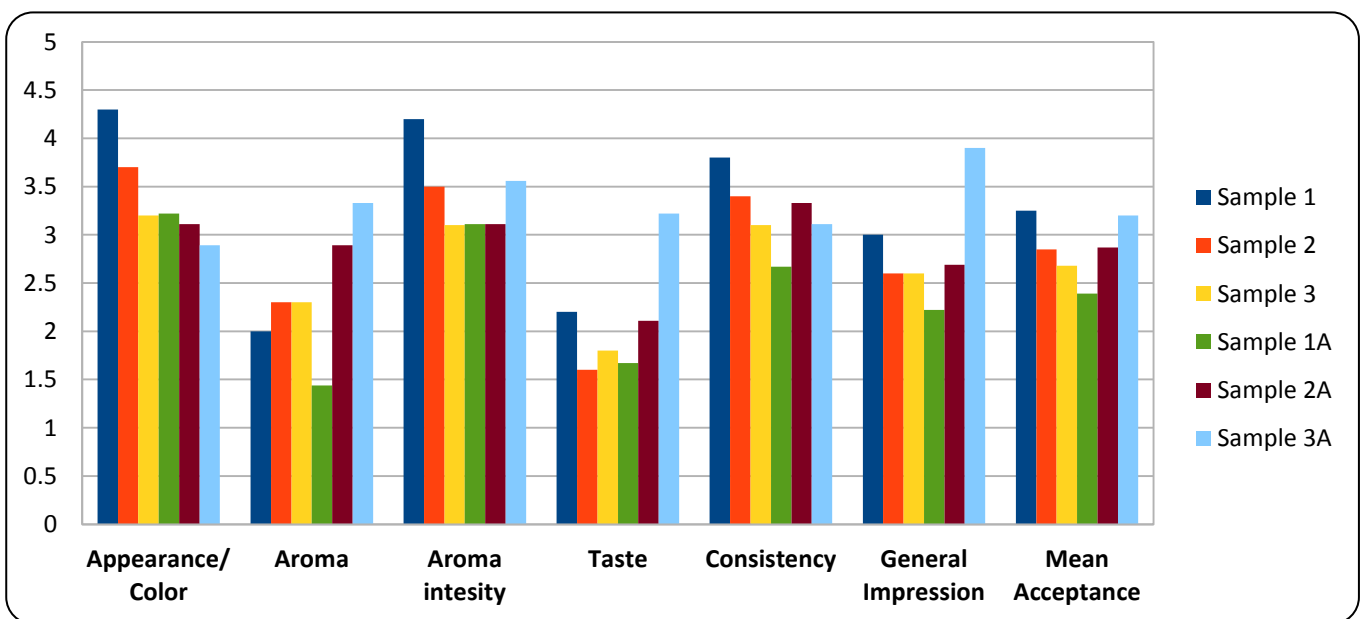


Fig 1. Data analysis on rating of all features for all samples involved in this research.

Correlation Analysis

The higher correlation value of 0.792 was found for the Aroma Intensity, followed by consistency 0.769, Taste 0.706, Aroma 0.595, and the lowest Appearance/Color 0.353.

General Statistics

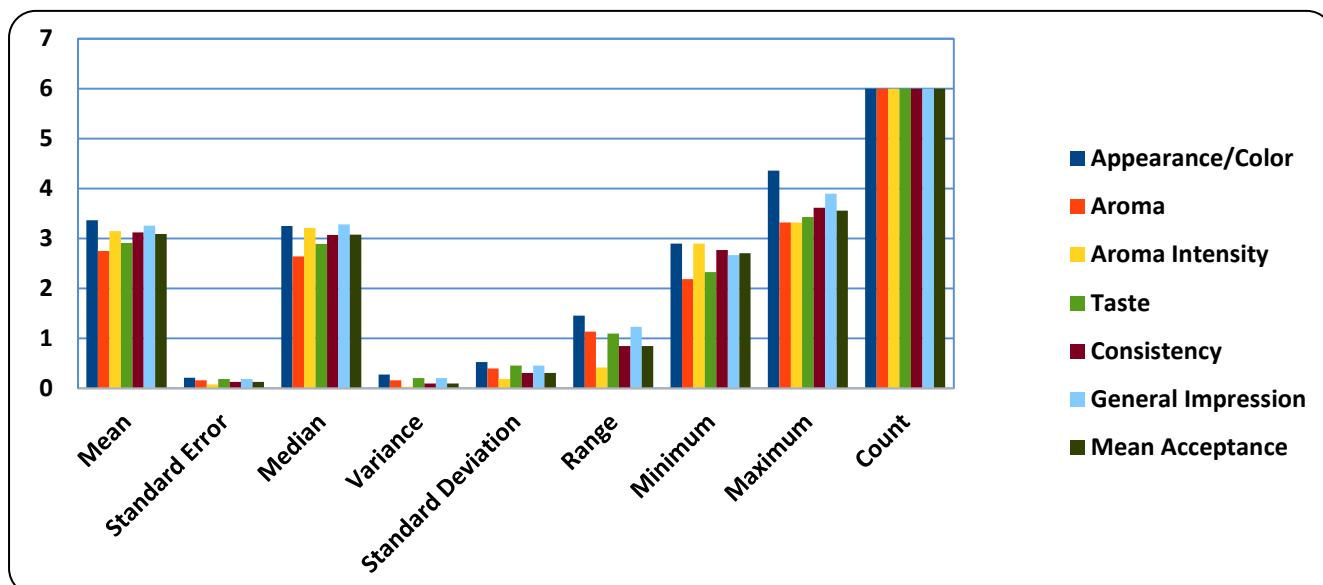


Fig 2. Column graph on General Statistics

IV. CONCLUSIONS

- The mean acceptance for sensory attributes of 6 samples varies from 2.39 to 3.25. The best ranged or best accepted by consumers was the wheatgrass juice - sample 1 - with a mean value of acceptance 3.25 (out of max. 5 point-excellent), SD 0.704, and CV 0.217.
- In the other hand the test revealed somewhat surprising results showing that the least accepted juice, with a mean of 2.39, SD 0.68, and CV 0.285, was exactly the best ranked sample – wheatgrass juice – in formulation with apple juice.
- The formulation of oat-grass juice 30% and apple juice 70% showed to be the best ranged from all the formulations of grass juices with apple juice, despite the fact that the oat-grass juice showed to be less liked grass juice when tested alone as a distinct juice. The reason for this may be the chemical reaction and interaction between ingredients which form a new aroma profiles when in a formulation. However, this may be considered as an indicator for the necessity to conduct further research on this topic, e.g. the sensory evaluation of the best accepted sample (wheatgrass) in formulation with other fruit juices.
- The highest correlation value of 0.792 was found for the Aroma Intensity, followed by Consistency 0.769, Taste 0.706, Aroma 0.595, and finally Appearance/Color 0.353.
- The mean Standard Deviation varies from 0.425 for sample 3A to 0.704 for sample 1, while the mean coefficient of variation varies between the min. 0.137 for 3A and max 0.285 for 1A.
- The juices were extracted using an Omega 8224 Nutrition Center Juicer, and the juice extraction yield expressed by 1 juice/kg grass was 0.7 l/kg for wheatgrass, 0.6 l/kg for barley-grass, and 0.8 l/kg for the oat-grass.
- The tests revealed an average sensory acceptance and a very good extraction yield, thus suggesting a good commercial potential for the products.
- Finally, we can conclude that this study will provide a useful insight into production and marketing strategies for a new juice line- green juices containing grass juices.

V. REFERENCES

- [1] Nanasombat et al 2014, Functional Foods in Health and Disease 2015; 5(1):1-16.
- [2] Singhal Ashish et al. IRJP 2012, 3 (7), Wheatgrass: an Alternative Household Nutritional Food Security, ISSN 2230 – 8407.
- [3] 3. Bodla Ramesh Babu, A study on wheat grass and its Nutritional value, ISSN 2225-0557; Vol. 2, 2011.
- [4] 4. Meyerowitz S. "Nutrition in Grass" Wheatgrass Nature's Finest Medicine: The Complete Guide to Using Grass Foods & Juices to Revitalize Your Health. 6th ed. Great Barrington (Massachusetts):

- Sproutman Publications; 1992. p.53.
- [5] Ashok Anup Shirude, Phytochemical and Pharmacological Screening of Wheatgrass Juice, ISSN 0976–044X.
- [6] 6. Dhalia et al, 2010, Multitude potential of wheatgrass juice (Green Blood): An overview, ISSN 0975-9212.
- [7] 7. Padalia et al 2010 Multitude Potential of Wheatgrass Juice (Green Blood).
- [8] 8. Chatham John 2012, Green Juicing Diet, pg 32. ISBN 978-1-62315-055-6.
- [9] 9. OECD fruit acid determination method

VI. LITERATURE

1. Acute intake of phenolic-rich juice improves antioxidant status in healthy subjects- Nutrition Research 26 (2006) 330– 339-Javier Garcí'a-Alonsoa, 4, Gaspar Rosa, M. Luisa Vidal-Guevarab, M. Jesu's Periagoa.
2. Chemical Engineering Journal -Production of green juice with an intensive thermo-mechanical fractionation process. Part I: Effects of processing conditions on the dewatering kinetics- P. Arlabossea,b, M. Blanca, b, S. Kerfaïc,d, A. Fernandezc,d,e.
3. Deconstructing a Fruit Serving: Comparing the Antioxidant Density of Select Whole Fruit and 100% Fruit Juices- 3 by the Academy of Nutrition and Dietetics.ISBN-2212-2672-Kristi Michele Crowe, PhD, RD, LD; Elizabeth Murray.
4. Evaluation of Antioxidant Profile and Activity of Amalaki (*Emblica Officinalis*), Spirulina And Wheat Grass- Indian Journal of Clinical Biochemistry, 2009 / 24 (1) 70-75- Vasudha Shukla, Manish Vashistha and Som Nath Singh.
5. Food–Sensory evaluation–Handbooks, manuals, etc. I. Hui, Y. H. (Yiu H.)
6. Green Smoothies for Beginners, John Chatham, ISBN- 978-1-62315-099-0.
7. Handbook of fruit and vegetable flavors / edited by Y.H. Hui. ISBN 978-0-470-22721-3.
8. Healing Drinks, juices, teas, soup and smoothies, Angela Dowden, Anne McIntyre ISBN: 1856751805.
9. Icef9 – 2004 International Conference Engineering and Food Process Development for Obtaining a Clarified Sport Drink from Natural Juices -Wolkoff, D.B; Pontes, S.M.2; Furtado, A.L.2; Cabral, L.C.2; Moretti, R.H.3; Matta, V.M.2.
10. Phytother. Res. 20, 218–227 (2006) , Evaluation of the Antioxidant Activity of Wheatgrass (*Triticum aestivum* L.) as a Function of Growth under Different Conditions- Sunil D. Kulkarni1, Jai. C. Tilak, R. Acharya, Nilima S. Rajurkar1, T. P. A. Devasagayam and A. V. R. Reddy.
11. Sensory Evaluation of Food Principles and Practices-Harry T. Lawless, Hildegard Heymann.
12. Solibam Organoleptic Tasting Guide- Camille VINDRAS, Nicolas SINOIR
13. The 40 Green Smoothie Recipes for Weight Loss-By Jenny Allan.
14. The edible flower garden / by Rosalind Creasy.-1st ed. ISBN: 978-1-4629-0617-8 (e-book).
15. The Healthy Green Drink Diet, 2011 by Jason Manheim, ISBN: 978-1-61608-473-8
16. http://annwigmores.org/living_foods.html
17. www.drugs.com/npc/barley-grass.html
18. http://annwigmores.org/living_foods.html
19. <http://www.sunburstsfoods.com/organic-oat-grass-juice-powder>.