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EVALUATION OF THE CHEMICAL COMPOSITION AND SENSORY PROPERTIES OF SOUR SOP (*Annona muricata*) AND WATERMELON (*Citrullus lanatus*) FRUIT JUICES AND BLENDS

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ABSTRACT

Background: Fresh fruits contain numerous nutrients that are essential for good health. Their highly perishable nature and prevalent poor preservation methods contribute to enormous losses in national income. The combination of different fruits in juice making will reduce spoilage, increase fruit intake, nutrient density and variety in food consumption.

Objective: The study evaluated the chemical composition and sensory properties of juices and blends prepared from Soursop (*Annona muricata*) and Watermelon (*Citrullus lanatus*) fruits.

Materials and methods: Fresh Soursop (S) and Water melon (W) fruits were purchased from Ndioro market in Ikwuano Local Government Area of Abia State Nigeria. The fruits were washed with clean tap water and systematically processed into juices. The juices were formulated into blends of 70W%: 30%S (500), 30%W: 70%S (501), 50%W: 50%S (502), 100%W (503), 100%S (504); and analyzed for nutrient composition and organoleptic properties using standard procedures. Data obtained was subjected to variance analysis, means differences ascertained with Duncan's Multiple Range Test and significant was judged at $p < 0.05$ using IBM Statistical Package for Service Solution (SPSS) version 21.0

Results: Sample 504 (100% Soursop) had significantly higher carbohydrate (13.21%), protein (0.83%), ash (1.11%), magnesium (32.14mg/100g), sodium (4.81mg/100g), Calcium (73.63mg/100g), potassium (611.14mg/100g), and Vitamin C (148.20mg/100g) content than the other samples. Sample 503 (100%Watermelon) had significantly higher crude fiber (0.21%), fat (0.42%), moisture (86.45%) and Vitamin A (710.34IU) content than other samples. Sample 501 (30%W: 70%S) had appreciable protein (0.77%), ash (0.82%), carbohydrate (12.67%), sodium (4.28%), calcium (69.11mg/100g), potassium (560.72mg/100g), phosphorus (53.25mg/100g), and Vitamin C (131.30mg/100g) second to 504(100% Soursop). Although 503 (100%Watermelon) was rated higher in flavor and color, all blends were generally acceptable to the panelists.

Conclusion: Soursop and Watermelon juices and blends had varied nutrient density and were generally acceptable to the panelists.

Keywords: *Nutrient composition, sensory qualities, soursop, watermelon, juice blends.*

INTRODUCTION

Fruits are the edible fleshy parts of the flowering plants that are beneficial for good health [1]. In Nigeria, different fruits abound. They come in different forms, shape, colors and nutrient contents; examples include but not limited to oranges, soursop, watermelon, mangoes, pineapple, grapes, star fruits, star apple, bananas, lemons, and velvet tamarind. They contain varieties of nutrients such as simple sugar and more especially minerals, vitamins and phytochemicals that are important aspect of adequate diet and necessary for boosting immune function [2,3]. Nutrients from fruits have been associated with reduction in the risk of major degenerative diseases [4,5]. Vitamin C for instance is most frequently abundant in fruits and have the potential to prevent lipid peroxidation, reduce oxidative stress and atherosclerotic processes [6]. The nutrient composition of fruits are most times related to their colors, type and forms [7]. Fruits could be sweet, sour, bitter or salty in taste, chewy, crunch or fibrous in mouth feel. Most fruits are seasonal and as such usually not available throughout the year. Frequently, there may be occurrence of a particular fruit in abundant quantities in some locations, unlike in other places resulting in lack of variety and uneven distribution across different locations. Consequently, majority of people are unable to consume varied fruits in sufficient amounts. A typical example is Watermelon (*Citrullis lanatus*), a round, oblong/spherical shaped fruit with green rinds that are sometimes spotted, grown abundantly in the Northern part of Nigeria but can be found growing wild in the Western and Southern African. It has high water content (92%), 6% sugar, very rich in potassium,

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lycopene, L-citrulline, vitamin A, B_6 and C [8]. It is known to improve appetite, reduce thirst and muscle soreness in athletes [9]. Its juiciness and high energy content have also been underscored [10, 11]. Soursop (*Anonna muricata*) on its own originated in Tropical American and is found growing in the Eastern parts of Nigeria. It is a large green fruit with cones in its skin. It has black seeds embedded in white juicy mesocarp with delectable flavor. It is of two species, sweet and sour types. The medicinal benefits of soursop include worm expellant, treatment for stomach and liver ailments, vomiting, skin infections, urethritis, leprosy, and haematuria, very effective in treatment of head lice and bedbug [12, 13]. Storage of soursop results in discoloration of peel, loss of water and changes in flavor [12].

Most fruits including watermelon and soursop have antioxidant activity [14] and can prevent atherosclerosis [6], a disease that is ravaging the health of most adults. Their seasonality and highly perishable nature make them prone to nutrients losses if allowed to store for long periods. Their low shelf-life can aggregate to great harvest losses due to inadequate post-harvest storage facilities and poor preservation methods. Human wants are insatiable. The demand for new products with different taste and nutrient density is positively accelerating due to increase in nutrition information and consumer health concerns as well as quest for healthy foods. The highly perishable nature of fruits makes it necessary for their pulp to be extracted, pressed or squeezed to obtain clear or uniformly cloudy unfermented liquids referred to as juice. Juices are fermentable and expected to have the characteristic color, flavor and taste typical of the juice of the fruit from which it comes [15]. Juicing of fruits is a means of ensuring all year-round availability of seasonal fruits. Fruit juices differ in form, nutrient contents and fiber levels. Their nutrient contents also depend on method of preparation (peeling, pulp removal, use of baking soda in cooling water), amount used, storage condition and amount consumed. Evidence suggests that nutrients in juices especially vitamins, minerals and bioactive compounds are readily available to the body for absorption than from the whole fruit; a characteristic attributed to higher amount of pectin in the whole fruits limiting absorption or break down of fruit cell wall during juicing leading to release of more nutrients [16, 17, 18, 19]. Several studies have shown that fruit juice consumption is associated with high nutrient density and better-quality diets [20, 21, 22, 23, 24]. There is therefore need for more methods of preparation or transformation to improve consumption of good foods, as the blending of different fruits in juice making will not only reduce nutrient losses (as more fruits will be used for juicing), it will also promote easy access to fruits, increase nutrient density and add variety in fruit intake.

MATERIALS AND METHODS:

Selection of subjects

Twenty panelists willing to participate in the sensory evaluation of the juice blends were randomly selected from the staff and students of Michael Okpara University of Agriculture Umudike, Abia State Nigeria.

Collection of samples

Soursop (Annona muricata) and wate melon (Citrullus lanatus) used for this study were purchased from a local market – Ndioro in Ikwuano Local Government Area, Abia State Nigeria. The fruits were identified by a crop scientist in the Department of Crop Science, Michael Okpara University of Agriculture Umudike, Nigeria.

Preparation of samples

Fresh whole Soursop and Watermelon fruits were washed properly with tap water, peeled to remove the skin, and allow for easy removal of the seeds to obtain only the pulp. The pulps were individually chopped into smaller slices, milled in an electric KENWOOD Food blender (Model BL335 made in China) for 10mins. The milled pulps were mixed with 400mls of water each and sieved with muslin cloth (pore size 2mm) and cheese cloth (grade #60) to separate the residue from the filtrate and obtain individual soursop and watermelon juices free from small particles as described [25]

Blending of the juices

Watermelon juice labeled W and Soursop juice labeled S, were formulated into blends of 70W%: 30%S, 30%W: 70%S, 50%W:50%S, 100%W and 100%S and coded as 500, 501, 502, 503 and 504 respectively to obtain a total of 5 juice blends for the study.

Chemical analysis

The proximate, mineral and vitamin contents of the juice blends were carried out in triplicates using standard methods. The moisture, protein, fat, ash, crude fiber contents of the juice blends were determined by method of AOAC [26]. Carbohydrate was determined by differences. Beta carotene was determined by method described by the International Vitamin A Consultative Group (IVACG)[27]. Vitamin C, magnesium, sodium, calcium potassium and phosphorus were also determined as described [26]. Sensory evaluation of the juices and blends was by twenty panelists using 7-point hedonic scale, where 7 was assigned the highest score of – liked extremely and 1 the lowest score – extremely disliked as described in Adegunwa *et al*. [28]. The mean scores for sensory attributes were recorded.

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Statistical analysis

Data obtained were analyzed with IBM Statistical Package for Service Solution (SPSS) version 21.0 software. Results was presented as means, and standard deviation. Analysis of variance (ANOVA) was used to compare the means, differences between means was determined with Duncan's Multiple Range Test and significant was accepted at $p < 0.05$

RESULTS

Table 1 presents the proximate, composition of Soursop (*Annona muricata*) and Watermelon (*Citrullus lanatus*) juices and blends. The moisture contents of the juice blends (70W%: 30%S, 30%W: 70%S, 50%W:50%S, 100%W and 100%S) ranged from 85.05 to 86.45%; protein, crude fiber, fat, and ash ranged from 0.56 to 0.83%; 0.11 to 0.21%; 0.21 to 0.42%; and 0.52 to 1.11% respectively. Samples 503 (100%W) had the highest contents of moisture, crude fiber and fat, while sample 504 (100%S) had highest contents of crude protein, ash, carbohydrate and energy respectively. Sample 501 (30%W: 70%S) had appreciable contents of crude protein, ash, carbohydrate and energy compared to samples 500 (70W%: 30%S) and 502 (50%W:50%S)

Table 1: Proximate composition of *Annona muricata* and *Citrullus lanatus* fruit juices blends (%)

Nutrients	Samples				
	500	501	502	503	504
Moisture (%)	86.12^{b} ±0.28	85.22^{d}±0.28	85.88^{c}±0.43	86.45^{a}±0.28	85.05^{e}±0.22
Crude protein (%)	0.64^{d}±0.21	0.77^{b}±0.14	0.72^{c}±0.14	0.56^{e}±0.21	0.83^{a}±0.14
Crude fiber (%)	0.18^{c}±0.00	0.14^{d}±0.14	0.17^{c}±0.17	0.21^{a}±0.21	0.11^{e}±0.14
Fat (%)	0.39^{b}±0.14	0.28^{d}±0.00	0.33^{c}±0.07	0.42^{a}±0.14	0.21^{e}±0.07
Ash (%)	0.61^{d}±0.13	0.82^{b}±0.21	0.77^{c}±0.14	0.52^{e}±0.22	1.11^{a}±0.14
Carbohydrate (%)	11.89^{b}±0.14	12.67^{ab}±0.07	12.43^{ab}±0.89	11.9^{b}±0.59	13.21^{a}±0.59
Energy (Kcal)	53.63^{d}±0.13	56.28^{b}±0.27	55.57^{c}±0.13	53.62^{e}±0.01	58.05^{a}±0.95

Means ± standard deviation of three determinations; Means with different superscripts in the same row are significantly different (P>0.05); Key: 500 = 70W%: 30%S, 501 = 30%W: 70%S, 502 = 50%W: 50%S, 503 = 100%W, 504 = 100%S

Table 2 shows the mineral and vitamin composition of *Annona muricata* and *Citrullus lanatus* fruit juices and blends in mg/100g. The minerals contents of the *Annona muricata* and *Citrullus lanatus* fruit juice blends (70W%: 30%S, 30%W: 70%S, 50%W:50%S, 100%W and 100%S) shows that the magnesium contents ranged from 27.04 to 32.14mg; sodium 2.13 to 4.81mg; calcium 24.82 to 73.63mg; potassium 429.04 to 611.14mg; and phosphorus 43.85 to 61.12mg respectively. Vitamin C and beta carotene contents of *Annona muricata* and *Citrullus lanatus* fruit juices blends (70W%: 30%S, 30%W: 70%S, 50%W:50%S, 100%W and 100%S) ranged from were 93.50 to 148.20mg and 490.61 to 710.34IU respectively. Sample 504 (100%S) had highest contents of all the micronutrients analyzed in this study except beta-carotene, followed by sample 501 (30%W: 70%S). Sample 503 ((100%W)) had the least content of micronutrients compared to other blends.

Table 2: Mineral and vitamin composition of *Annona muricata* and *Citrullus lanatus* fruit juices (mg/100g).

Nutrients	Samples				
	500	501	502	503	504
Magnesium (mg)	29.42^{d}±0.00	30.44^{c}±0.21	31.38^{b}±0.21	27.04^{e}±0.30	32.14^{a}±0.28
Sodium (mg)	2.61^{e}±0.14	4.28^{b}±0.14	3.22^{c}±0.21	2.13^{d}±0.36	4.81^{a}±0.14
Calcium (mg)	33.06^{d}±0.28	69.11^{b}±0.07	40.15^{c}±0.14	24.82^{e}±0.28	73.63^{a}±0.28
Potassium (mg)	504.14^{d}±0.50	560.72^{b}±0.28	522.63^{c}±0.28	429.04^{e}±0.04	611.14^{a}±0.04
Phosphorus (mg)	50.15^{d}±0.21	53.25^{b}±0.21	52.16^{c}±0.28	43.85^{e}±0.21	61.12^{a}±0.28
Vitamin C (mg)	104.10^{d}±0.14	131.30^{b}±0.14	128.50^{c}±0.28	93.50^{e}±0.14	148.20^{a}±0.14
Beta carotene (IU)	603.10^{b}±0.07	505.12^{d}±0.02	526.18^{c}±0.12	710.34^{a}±0.06	$490..61^{e}$±0.28

Means ± standard deviation of three determinations; Means with different superscripts in the same row are significantly different (P>0.05); Key: 500 = 70W%: 30%S, 501 = 30%W: 70%S, 502 = 50%W: 50%S), 503 = 100%W, 504 = 100%S

Table 3 shows the sensory qualities of *Annona muricata* and *Citrullus lanatus* fruit juices and blends (mg/100g). The sensory scores of the *Annona muricata* and *Citrullus lanatus* fruit juices and blends (70W%: 30%S, 30%W: 70%S, 50%W:50%S, 100%W and 100%S) recorded the appearance score range of 4.00 to 6.04 on a 7-point Hedonic scale. Taste ranged from 4.70 to 5.73; flavor from 4.09 to 6.02; consistency from 5.20 to 6.14; color from 4.81 to 5.82 and overall acceptability of 4.38 to 6.14 respectively. Sample 503 (100% W) scored highest in all the sensory property scores.

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Table 3: Table 3 **Sensory qualities of *Annona muricata* and *Citrullus lanatus* fruit juice blends (mg/100g).**

Sensory parameters	Samples				
	500	501	502	503	504
Appearance	4.00^{b} ±1.30	5.52^{a}±1.90	4.80^{ab}±1.10	6.04^{a}±0.08	5.80^{e}±1.02
Taste	4.70^{d} ±1.25	5.4^{b} ±0.94	5.27^{c}±0.04	5.65^{a} ±0.57	5.73^{a}±0.55
Flavor	4.90^{b}±1.31	5.51^{ab}±1.04	5.31^{ab}±1.02	6.02^{a}±1.72	5.61^{ab}±1.09
Consistency	5.20^{ab}±1.20	5.32^{ab}±1.13	5.23^{ab}±1.70	6.14^{a}±0.14	5.52^{ab}±1.07
Color	4.81^{b}±1.02	5.28^{ab}±1.31	5.27^{ab}±1.34	5.82^{a}±0.82	5.41^{ab}±1.20
Overall acceptability	4.38^{b}±1.11	5.37^{ab}±0.07	4.73^{ab}±1.08	6.14^{a}±0.59	5.72^{ab}±0.94

Means ± standard deviation of three determinations; Means with different superscripts in the same row are significantly different (P>0.05); Key: 500 = 70%W: 30%S, 501 = 30%W: 70%S, 502 = 50%W: 50%S), 503 = 100%W, 504 = 100%S

DISCUSSION

Analysis of proximate content is valuable in determining the nutrient composition of foods. In this study, the proximate composition of sample 503 (100% watermelon) and sample 504 (100% Soursop) varied and were different as reported [8, 12]. This is because of factors like variety, regional differences, climatic conditions, state of maturity, freshness, and method of formulation of the product [29]. The proximate content of the juice blends (70W%: 30%S, 30%W: 70%S, 50%W:50%S, 100%W and 100%S) showed that the moisture contents of the juices and blends although significantly (P<0.05) different from each other were high as expected in fruit juices. High moisture content is a characteristic feature of juices and fresh fruits are known to possess more water especially when juiced. This is in consonance to United States Department of Agriculture (USDA) document on water composition of foods [30]. Sample 503 (100% water melon) had significantly higher (P<0.05) moisture content than the other blends. This is because water melon fruit has more water content than soursop and reduction in the quantity of watermelon used during blending will amount to lower moisture content of the other juice blends. In addition, it could be due to variety and season. Fruits obtained in rainy season are known to possess higher moisture content than those obtained in dry season. The moisture content of juices in this study conducted during rainy season were lower than 92% reported by Fortin [8] for water melon and the 88.0% and 90.0% reported by Ogbuonye *et al*. [31] for honey and Jack fruit sweetened Zobo drinks but higher than 82.00 to 82.53% for some selected fruit juices produced in Nigeria [32]. The lower moisture content of these juice blends could mean that they will have a relatively longer shelf life than juices with higher moisture content as high moisture encourages the growth of micro-organisms and reduces storage life. Fruits generally have low protein content. The protein content of the juice blends (table 1) were higher relative to 0.61% and 1.0% reported by Fortin [8] and Obizoba *et al*. [12] for 100% watermelon and soursop respectively. The low protein value of the blends makes the juice blends ideal for low protein diet. The crude fiber content of sample 503 (100% watermelon) was significantly (P<0.05) higher than the other blends with sample 504 (100% Soursop) having the lowest value. These values were lower than 0.4% reported for water melon (2), 3.3% for soursop [12] and 0.53 to 0.4% reported for Cucumber juice and Zobo drink [33, 31] respectively. The lower fiber contents of the juice blends were expected and could be explained by the significant removal of fiber during filtration in juicing, thus makes the juice blends ideal for people on low fiber diet. The report that watermelon is fat free or contains no cholesterol of dietary significance 11] is in consonance with the 0.42 to 0.21% recorded in this study. The latter were relatively higher than 0.15%, 0.3% and .05 to 0.05% reported by other studies [8, 12, 32] respectively. These differences in fat value could be attributed to specie differences. All the same, the general low-fat value of fruit juices is advantageous to good health. Ash content of any food is directly related to its mineral content. The ash contents of samples 501 (30%W:70%S), 502 (50%W:50%S), 500 (70%W:30%S), were higher than 503 (100% watermelon) and 504(100% soursop). These indicates that the blends will contribute more minerals than the whole fruit juices. The juice blends ash values were lower when compared with cucumber (1.92%) and Zobo (2%) drinks [34, 31] respectively. The carbohydrate values of the juices and blends were higher than 7.6% reported for watermelon (2) and 13.54% for soursop [12], and equally higher than 0.97% for cucumber drink (26), 7.6 and 6.9% Zobo drink [31, 34]. The blends carbohydrate value is of nutritional benefit as the juices could be used to temporarily sustain hunger.

The micronutrients (magnesium, sodium, calcium, potassium, phosphorus, vitamin A, and C) content of the juice blends increased as the substitution of watermelon with soursop increased except for vitamin

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A. This indicates that blending watermelon juices with soursop is a value addition strategy to improve the mineral density of the juices as the blends can contribute richly to mineral contents of the diet. Sample 504 (100% soursop) had significantly higher ($P<0.05$) magnesium content than other blends. All the blends had high magnesium content than 27.04mg reported for sample 503 (100% watermelon) and 7.08 to 15.23mg for selected fruit juices produced in Nigeria [32] but lower than the 44.8mg reported for cucumber juice [33]. The high magnesium content of these blends is of health significance as magnesium is beneficial for potassium, and calcium metabolism, insulin function as well as in prevention of circulatory and coronary heart diseases [29, 35]. The calcium content of the juice blends ranged from 24.8 to 73.6%. Sample 504 (100% soursop) had significantly higher calcium value compared to 7mg obtained for 100% watermelon [8] and 14mg for soursop [12]. The blends calcium values were significantly lower than 241.2mg reported for cucumber juice [33], but higher than 5.24 to 18.45mg for selected fruit juices [32]. These differences in these studies were due to variety differences and method of preparation [29]. The blends calcium values although little could be used as an additional source of calcium and will contribute to calcium needs of consumers. The potassium value of sample 504(100% soursop) was significantly ($P<0.05$) higher than those of the other blends and far higher than 12mg reported for 100% watermelon [8] juice, and 96.86 to 138mg for selected fruit juices [32]. This could be due to differences in method of preparation and blending with soursop known to contain high potassium. The juice blends could therefore contribute significantly to good health as potassium is linked with reduced blood pressure and risk of stroke [36]. Watermelon has also been shown to be a rich source of potassium (5), dietary fiber, folate, antioxidant vitamins and can lower the risk of cardiovascular diseases - CVDs [37]. Although intake of whole fruits is preferable, juices have high potassium content which is beneficial to good health. Sample 504 (100% soursop) had equally higher phosphorus content than the other blends as well as 58.3% reported for water melon [8]. The blends' phosphorus contribution to the diet is vital as phosphorus has been associated with good bone and teeth formation [38]. The blends (2.13 to 4.18mg) had lower sodium values compared to 6.7 to 17.0 mg reported for selected fruit juices produced in Nigeria [32]. This information is vital for people on low salt diet as high sodium has been implicated in a lot of degenerative diseases [39].

The high vitamin A content of sample 503(100% watermelon) is expected as watermelon fruit has especially high amounts of lycopene and carotenoids which has been associated with prevention of asthma, diabetes, arthritis, hypertension and heart disease as well as reduction of prostate inflammation and lung cancer [40]. The vitamin C content increased as the quantity of soursop increased. Sample 503 (100% watermelon) had the least vitamin C value. The blends had significantly ($P<0.05$) higher vitamin C content than 8.1mg reported for watermelon [8] and 20.6% reported for soursop [12]. This could be explained as value addition effect due to substitution and blending of the fruit juices. Vitamin C have been shown to decrease oxidative stress and atherosclerotic processes, with potential roles in the prevention of lipid peroxidation and atherosclerosis [7]

The appearances, taste, flavor, and consistency scores of the juice blends ranged from 4.0 to 6.14 on a 7-point hedonic scale. These scores were lower than 6.92 reported by Umelo *et al*. [41] on watermelon juice. This could be attributed to, differences in method of preparation, species, and panelists. The sensory property scores of the juice blends showed that sample 503 (100% watermelon) scored highest in all the sensory attributes scores and subsequently had higher general acceptability. This was immediately followed by sample 504 (100% soursop) and thus confirmed the report that familiar products are more and easily acceptable than new products [42], although new products could gain more acceptance with continuous usage and information.

CONCLUSION

The study observed good combination of nutrients, variety in taste, color and appearances. Soursop and Watermelon juice blends had improved nutrient density and general acceptability and will contribute to increased fruit intake. The micronutrient (magnesium, sodium, calcium, potassium, and vitamin C) contents of the juice blends increased as the substitution of water melon with soursop increased except for vitamin A. The blending of water melon juice with soursop is a value-added strategy that improved the nutrient (especially the mineral) density of the juices. The blends can contribute richly to mineral content of the diet. Nutrition information on new value-added foods should be communicated to consumers through seminars and workshops to increase usage and acceptability.

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Ethics approval:

The study was approved by the Academic Board of Human Nutrition and Dietetics, College of Applied Food Sciences and Tourism, Michael Okpara University of Agriculture Umudike, Abia State Nigeria (MOUAU/CAFST/HNUD/AB/015/016).

Informed Consent:

Twenty panelists consisting of staff and students randomly selected from the of the University community were fully informed of the tenacity and procedures of the research and their personal consents obtained.

Conflict of interest

None

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Author Contribution

H,N. designed the concept of the study. D.C.F. collected, and analyzed the data, H.N. drafted and reviewed the manuscript. Both authors made contributions to improve the manuscript.

Data and material availability

The authors declare that the data and materials for this work are available

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