



P-ISSN: 2349-8528

E-ISSN: 2321-4902

IJCS 2018; 6(4): 393-397

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Received: 23-05-2018

Accepted: 24-06-2018

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Impact of *Aloe vera* juice and isabgol husk on microbial quality of wheat flour vermicelli

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Abstract

The present investigation was aimed to study the impact of *Aloe vera* juice and isabgol husk in microbial quality of wheat flour vermicelli. *Aloe vera* based vermicelli were prepared using seventeen treatment formulations of *Aloe vera* juice (18%, 20%, 22% and 24%), isabgol husk (0%, 0.5%, 1.0% and 1.5%) and wheat flour (100% - % *Aloe vera* juice and % isabgol husk) along with standard formulation (18% water and 82% wheat flour). Prepared vermicelli after cold extrusion were dried in dryer at 50°C temperature for 10 min to remove moisture up to 8 % followed by cooling at room temperature, packing in PP bags and storage at room temperature for six months for periodical analysis of microbial quality. The results of the present investigation indicate that the vermicelli prepared using 24% *Aloe vera* juice, 1% isabgol husk and 75% wheat flour (F₁₃) were found to resist microbial growth during six month of storage.

Keywords: *Aloe vera* juice, isabgol husk, wheat flour, extruder, vermicelli, water activity, total plate count and storage

Introduction

Vermicelli is an important cereal based extruded staple food conventionally made from refined wheat flour using 18-20 % water. Traditionally good quality vermicelli can be prepared from durum wheat flour due to its high gluten content. Wheat gluten is composed of glutenin and gliadin. These proteins together have excellent binding properties and are capable to form firm and elastic network with starch and water during dough formation (Sissons *et al.*, 2010) [41]. Vermicelli like products are widely accepted by the children and elders. Recent developments in extruded products include attempts to improve the nutritional properties of the product by the addition of supplements from various nutritional sources *viz.*, *Aloe vera* juices, Isabgol husk, *etc.*

Aloe vera (*Aloe barbadensis* Miller) belongs to Liliaceae family, traditionally being utilized as contemporary folk remedy. *Aloe vera* gel/ juices help to improve general immune system, help in prevention of arthritis, diabetes, cancer, maintain stomach acids, constipation, heart burns, regenerate tissues, increase absorption of nutrients and even neutralize toxic elements. *Aloe vera* extract have in-vitro anti-bacterial properties against various common pathogenic bacteria (Saritha *et al.*, 2010) [38]. The gel extract showed significant zone of inhibition against Gram positive bacteria with the exception of *B. cerus* and *B. subtilis* and also had inhibitory activity against Gram negative bacteria with the exception of *P. aeruginosa*. Specific plant compounds such as anthraquinones and di-hydroxy-anthraquinones as well as saponins have been proposed to have direct anti-microbial activity (Bradford and Awad, 2007) [8]. Thus, *Aloe* juice is utilized as functional foods especially for the preparation of health drinks with no laxative effects. It is also used in other food products including health foods by blending with cereals *viz.*, bread, extruded products, *etc.*

Isabgol husk has been used as a natural-fibre laxative (Chan and Wypyszyk, 1988) [10], to lower serum cholesterol levels in hypercholesterolemic patients (Bell *et al.*, 1989) [4] and glycemic and lipid levels in diabetic mice (Watters and Blaisdell, 1989) [44], to affect fecal and colonic microbial metabolism (Costa *et al.*, 1989) [12], and for prophylaxis and treatment of intestinal disorders (Cappel and Rece, 1989) [9]. Isabgol husk have high water-binding capacity and stability at a variety of pH levels and temperatures. It is considered as a food additive for improving shelf life, consumer acceptance and reducing stickiness (Ibuki, 1989) [20]. Isabgol husk can be utilized as an emulsifier, stabilizer and substitute for fat and wheat flour (Giuntini *et al.*, 2003) [16]. The inclusion of isabgol husk as a source of fibre in sponge cakes, bread,

regular white pan bread and noodles was reported by Czuchajowska *et al.* (1992) [13]. Its effect on the quality of dough and bread was reported by Nikouzadeh *et al.* (2008) [28] and its use in the production of biscuits reported by Raymundo *et al.* (2014) [36].

Till date, no efforts have been made nor reported in literature for utilization of *Aloe vera* with isabgol husk for preparation of *Aloe vera* based vermicelli. Thus, nutritional and medicinal properties of *Aloe vera* juice and isabgol husk can be exploited for preparation of *Aloe vera* based vermicelli.

Material and Methods

Mature leaves of *Aloe vera* were procured from Medicinal and Forest Plant Nursery, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and M/s Govindbhai, *Aloe vera* grower, Gariyadhar, Bhavnagar and brought to Department of Post-Harvest Technology, ASPEE College of Horticulture and Forestry, NAU, Navsari. *Aloe vera* leaves were analyzed for various physico-chemical characteristics and then used for further experimentation.

Wheat flour and isabgol husk used for preparation of *Aloe vera* based vermicelli were procure from Navsari market and were also analyzed for various parameters prior to experimentation. After proximate analysis, raw materials were prepared for utilization under experiment.

Aloe vera based vermicelli were prepared using different proportion of *Aloe vera* juice, isabgol husk and wheat flour. Water was used in standard formulation for preparation of vermicelli and kept as control. A total of seventeen different treatment formulations as detailed in Table 1 were used for preparation of vermicelli. Vermicelli of different formulations were prepared using Dolly extruder by kneading the entire ingredient as per treatment combinations (Table 1) in feeding section of extruder followed by cold extrusion. Extruded vermicelli were dried in dryer at 50°C temperature for 10 min to remove moisture up to 8 % followed by cooling at room temperature, packing in 200 gauge PP bags and storage at room temperature for six months for periodical analysis. Principal steps used for preparation of vermicelli are given in Figure 1.

Table 1: Detail of treatment formulations used for preparation of *Aloe vera* based vermicelli

Formulation No.	Treatment details
F ₁	Water 18 % + 82 % Wheat flour (Control)
F ₂	<i>Aloe vera</i> juice 18 % + 82 % Wheat flour
F ₃	<i>Aloe vera</i> juice 20 % + 80 % Wheat flour
F ₄	<i>Aloe vera</i> juice 22 % + 78 % Wheat flour
F ₅	<i>Aloe vera</i> juice 24 % + 76 % Wheat flour
F ₆	<i>Aloe vera</i> juice 18 % + 0.5 % Isabgol husk + 81.5 % Wheat flour
F ₇	<i>Aloe vera</i> juice 20 % + 0.5 % Isabgol husk + 79.5 % Wheat flour
F ₈	<i>Aloe vera</i> juice 22 % + 0.5 % Isabgol husk + 77.5 % Wheat flour
F ₉	<i>Aloe vera</i> juice 24 % + 0.5 % Isabgol husk + 75.5 % Wheat flour
F ₁₀	<i>Aloe vera</i> juice 18 % + 1.0 % Isabgol husk + 81.0 % Wheat flour
F ₁₁	<i>Aloe vera</i> juice 20 % + 1.0 % Isabgol husk + 79.0 % Wheat flour
F ₁₂	<i>Aloe vera</i> juice 22 % + 1.0 % Isabgol husk + 77.0 % Wheat flour
F ₁₃	<i>Aloe vera</i> juice 24 % + 1.0 % Isabgol husk + 75.0 % Wheat flour
F ₁₄	<i>Aloe vera</i> juice 18 % + 1.5 % Isabgol husk + 80.5 % Wheat flour
F ₁₅	<i>Aloe vera</i> juice 20 % + 1.5 % Isabgol husk + 78.5 % Wheat flour
F ₁₆	<i>Aloe vera</i> juice 22 % + 1.5 % Isabgol husk + 76.5 % Wheat flour
F ₁₇	<i>Aloe vera</i> juice 24 % + 1.5 % Isabgol husk + 74.5 % Wheat flour

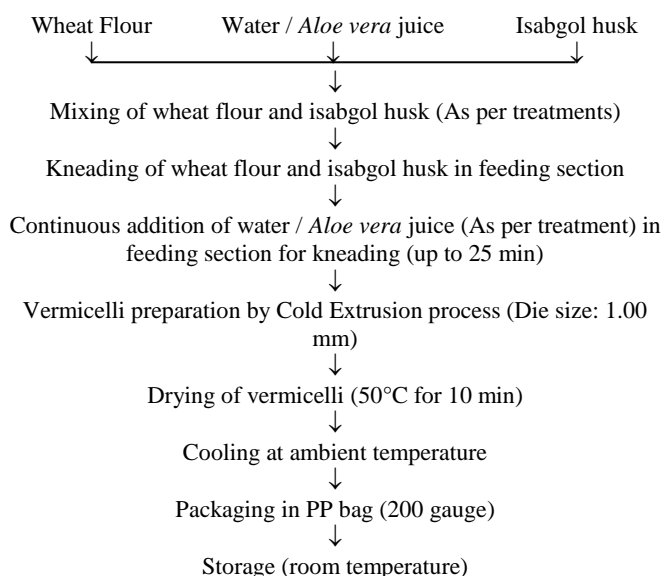


Fig 1: Principal steps used for preparation of *Aloe vera* based vermicelli

Simple water activity meter (Model: LabStart-a_w) was used for measurement of water activity of samples. Total Plate Count (TPC) of samples were estimated aseptically by

inoculating 0.1 ml of serially diluted sample in petri-plates containing LB agar medium prepared according to Ranganna (1997) [35]. The samples (1 g) after serial dilution (10^{-2} , 10^{-3} and 10^{-5}) were spread over the LB agar plates in laminar air flow. Then the plates were incubated at 37°C for 24 h followed by colony count. The results of the total plate count (TPC) were expressed as CFU/g of sample.

Results and Discussion

The physico-chemical characteristics of fresh *Aloe vera*, isabgol husk and wheat flour are presented in Table 2. Results for physico-chemical parameters are in line with the observations made by Raj *et al.* (2017) [31] Jain (2016) [23], Vaghshiyah (2015) [43], Ahlawat *et al.* (2014) [1], Elbandy *et al.* (2014) [14], Hamid *et al.* (2014) [18], Ramachandran and Nagarajan (2014) [34], Tiwari and Deen (2014) [42], Chandegara and Varshney (2013) [11], Sasi *et al.* (2013) [39] and Boghani *et al.* (2012) [6] for *Aloe vera* juice; Kamaljit *et al.* (2011) [25], Beikzadeh *et al.* (2016) [3], Qaisrani *et al.* (2014) [29] Marlett and Fischer (2003) [26] and Guo *et al.* (2008) [17] for isabgol husk; Fistes *et al.* (2014) [15], Kamaljit *et al.* (2011) [25], Hrusková and Machova (2002) [19], Shenoy and Prakash (2001) [40] and Boyacioglu and D'apponia (1994) [7] for wheat flour.

Table 2: Physico-chemical parameters of *Aloe vera* juice, Isabgol husk and Wheat flour used for preparation of vermicelli

Sr. No.	Physico-chemical parameters	<i>Aloe vera</i> juice	Isabgol husk	Wheat Flour
1	Moisture content (%)	99.10	9.83	8.68
2	Acidity (%)	0.028	0.045	0.117
3	TSS (°B)	0.70	6.50	18.75
4	Total Sugars (%)	0.618	0.674	2.125
5	Reducing sugars (%)	0.298	0.293	0.282
6	Non-reducing sugars (%)	0.304	0.362	1.751
7	Fibre (%)	0.071	5.282	1.450
8	Starch (%)	-	29.85	64.80
9	Calcium (mg/100g)	33.96	13.10	8.50
10	Sodium (mg/100g)	35.70	31.64	6.43
11	Potassium (mg/100g)	58.51	74.78	32.72

Water activity: Perusal of data pertaining to effect of different treatment formulations on water activity of *Aloe vera* based vermicelli during 6 month storage has been presented in Table 3. Data shows that among different formulations, the mean water activity of vermicelli (F) varied significantly between 0.58 and 0.64, with minimum water activity in vermicelli which were prepared using 24 % *Aloe vera* juice + 1 % isabgol husk + 75 % wheat flour (F₁₃) statistically at par with formulations F₉ and maximum in vermicelli prepared using 18 % *Aloe vera* juice + 1.5 % isabgol husk + 80.5 % wheat flour (F₁₄) statistically at par with formulations F₁. Water activity of bread was higher in bread prepared with 4% psyerloid than in control as reported by Czuchajowska *et al.* (1992) [13]. Similarly, Beikzadeh, *et al.* (2016) [3] observed that the increase of husk percentage up to 5% increased the water activity of cake, after which it decreased day after baking. Data depicts that during six months storage, the mean water activity of vermicelli (S) increased significantly from 0.52 to 0.68 (S₁ to S₃). Ramachandra and Rao (2011) [32] also reported gradual increase in water activity of dehumidified air dried *Aloe vera* gel powder during accelerated storage. It may be due to absorption of moisture during storage which might be attributed to permeability of the packaging material toward moisture absorption. The similar reason for other processed products had been reported by Raj *et al.* (2009) [30] for dehydrated onion rings. Interactions of formulations and storage (FS) were found to have significant effect. Six month storage of vermicelli prepared using different formulations resulted minimum increase (0.56 to 0.60) of water activity in vermicelli which were prepared using formulation F₁₃ (24 % *Aloe vera* juice + 1 % isabgol husk + 75 % wheat flour) and maximum decrease (0.48 to 0.76) in F₁₄ (18 % *Aloe vera* juice + 82 % wheat flour) statistically at par with formulations F₁. Bhargawa *et al.* (2014) [5] observed non-significant effect of storage on water activity of chapatti supplementation with 3 % *Aloe vera*.

Total Plate Count (TPC): Perusal of data pertaining to effect of different treatment formulations on total plate count ($\times 10^2$ CFU/g) of *Aloe vera* based vermicelli during 6 month storage has been presented in Table 3. Data shows that among

different formulations, the mean total plate count of vermicelli (F) varied significantly between 6.20×10^2 CFU/g and 1.23×10^2 CFU/g, with minimum total plate count in vermicelli which were prepared using 24 % *Aloe vera* juice + 1 % isabgol husk + 75 % wheat flour (F₁₃) and 24 % *Aloe vera* juice + 1.5 % isabgol husk + 74.5 % wheat flour (F₁₇) and maximum in vermicelli prepared using 18 % water + 82 % wheat flour (F₁). This might be attributed to presence of TPC in wheat flour. ISI: 7463 (1988) [22] have reported the TPC of 100,000/g in wheat flour as a safe limit. In conformity with the present investigation, More *et al.* (2017) [27] reported that milk shake prepared without *Aloe vera* showed highest standard plate count (4.25×10^6 CFU/g) as compared to milk shake prepared with 5 % *Aloe vera* (1.75×10^6 CFU/g).

During six months storage, the mean total plate count of vermicelli (S) increased significantly from 1.39×10^2 CFU/g to 2.32×10^2 CFU/g (S₁ to S₃). Further the microbial load was observed non-pathogenic in all the treatments. Aruna *et al.* (1998) [2] observed an increasing trend in microbial count of cereal based papaya powder during storage period of 9 months and attributed this increase as a result of rise in moisture content. Interactions of formulations and storage (FS) were also found to have significant effect. Six month storage of vermicelli prepared using different formulations resulted minimum increase (1.20×10^2 CFU/g to 1.30×10^2 CFU/g) in total plate count of vermicelli which were prepared using formulation F₁₃ (24 % *Aloe vera* juice + 1 % isabgol husk + 75 % wheat flour) and F₁₇ (24 % *Aloe vera* juice + 1.5 % isabgol husk + 74.5 % wheat flour) and maximum increase (1.80×10^2 CFU/g to 12.10×10^2 CFU/g) in F₁ (18 % water + 82 % wheat flour). Ramachandran (2014) [33] also reported significantly lower yeast and mold count (YMC) for 3 % *Aloe vera* gel and 4.5 % *Aloe vera* gel supplemented functional papaya powder. This absence in YMC during storage could be attributed to the potent antifungal efficacy of *Aloe* gel described in several studies (Saks and Barkai Golan, 1995; Jasso de Rodriguez *et al.*, 2005) [37, 24]. The enumerated values of present investigation are much lower than the ISI specification of maximum permissible level of total plate count of 50,000 CFU/g for snack items (ISI, 1975) [21].

Table 3: Effect of formulations on water activity and total plate count of *Aloe vera* based vermicelli during storage

Formulations* (F)	Water activity (a_w)				Total plate count ($\times 10^2$ CFU/g)			
	Storage (S)			Mean (F)	Storage (S)			Mean (F)
	Initial (S ₁)	3 month (S ₂)	6 month (S ₃)		Initial (S ₁)	3 month (S ₂)	6 month (S ₃)	
F ₁ : Control	0.49	0.65	0.75	0.63	1.80	4.70	12.10	6.20
F ₂ : A ₁₈ +W ₈₂	0.49	0.64	0.72	0.62	1.60	1.80	2.10	1.83
F ₃ : A ₂₀ +W ₈₀	0.50	0.64	0.69	0.61	1.60	1.80	2.00	1.80
F ₄ : A ₂₂ +W ₇₈	0.52	0.63	0.68	0.61	1.40	1.60	1.80	1.60
F ₅ : A ₂₄ +W ₇₆	0.53	0.62	0.66	0.60	1.30	1.40	1.60	1.43
F ₆ : A ₁₈ +I _{0.5} +W _{81.5}	0.50	0.62	0.70	0.61	1.50	1.70	2.10	1.77
F ₇ : A ₂₀ +I _{0.5} +W _{79.5}	0.52	0.61	0.68	0.60	1.40	1.70	1.90	1.67
F ₈ : A ₂₂ +I _{0.5} +W _{77.5}	0.53	0.62	0.66	0.60	1.30	1.50	1.60	1.47
F ₉ : A ₂₄ +I _{0.5} +W _{75.5}	0.55	0.60	0.63	0.59	1.30	1.40	1.50	1.40
F ₁₀ : A ₁₈ +I ₁ +W ₈₁	0.49	0.64	0.72	0.62	1.40	1.60	1.90	1.63
F ₁₁ : A ₂₀ +I ₁ +W ₇₉	0.52	0.62	0.67	0.60	1.40	1.50	1.70	1.53
F ₁₂ : A ₂₂ +I ₁ +W ₇₇	0.54	0.61	0.65	0.60	1.30	1.40	1.60	1.43
F ₁₃ : A ₂₄ +I ₁ +W ₇₅	0.56	0.59	0.60	0.58	1.20	1.20	1.30	1.23
F ₁₄ : A ₁₈ +I _{1.5} +W _{80.5}	0.48	0.68	0.76	0.64	1.40	1.60	1.90	1.63
F ₁₅ : A ₂₀ +I _{1.5} +W _{78.5}	0.50	0.64	0.69	0.61	1.30	1.40	1.60	1.43
F ₁₆ : A ₂₂ +I _{1.5} +W _{76.5}	0.52	0.63	0.66	0.60	1.30	1.40	1.50	1.40
F ₁₇ : A ₂₄ +I _{1.5} +W _{74.5}	0.54	0.61	0.65	0.60	1.20	1.20	1.30	1.23
Mean (S)	0.52	0.63	0.68		1.39	1.70	2.32	
	S.Em.±	C.D. at 5%	C.V. %		S.Em.±	C.D. at 5%	C.V. %	
Formulation (F)	0.004	0.01	2.33		0.01	0.03	1.75	
Storage (S)	0.002	0.01			0.01	0.02		
Interaction FS	0.008	0.02	2.19		0.03	0.07	2.43	

*A: *Aloe vera* juice %; I: Isabgol husk %; W: Wheat flour %
Control: 18% Water + 82 % Wheat Flour

Conclusions

It can be concluded that vermicelli prepared using *Aloe vera* juice along with isabgol husk were lower in microbial growth during six month of storage as compared to control. Vermicelli prepared using 24% *Aloe vera* juice, 1% isabgol husk and 75% wheat flour (F₁₃) having lowest microbial growth during six month of storage can be recommended for preparation of *Aloe vera* based wheat flour vermicelli.

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