International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182 Print ISSN: 2349-5979
www.allsubjectjournal.com
Volume 3; Issue 1; January 2016; Page No. 217-222

Investigation of physico-chemical and microbial quality of two smoke-dried freshwater fish species; Chapila (*Gudusia chapra*) and baim (*Mastacembelus pancalus*) treated with salt-turmeric solution storage at room temperature (26-31 ^{0}C)

[1] Mosarrat Nabila Nahid, [2] Dr. Gulshan Ara Latifa, [3] Dr. Shubhash Chandra Chakraborty, [4] Farzana Binte Farid, [5] Mohajira Begum

[1, 2, 4] Department of Zoology, University of Dhaka, Dhaka, Bangladesh

[3] Department of Fisheries Technology, Bangladesh Agricultural University

[5] Institute of Food Science and Technology, Bangladesh Council of Scientific and industrial Research (BCSIR), Dhaka, Bangladesh

Abstract
This study assessed the comparative changes in sensory characteristics, microbiological quality and biochemical components of salt and turmeric (S+T) treated two different smoke-dried freshwater small fish, Chapila (*Gudusia chapra*) and Baim (*Mastacembelus pancalus*) during storage at room temperature (26-31 ^{0}C) using standard methods of analyses. It was revealed that salt and turmeric treated smoke-dried Chapila (*G. chapra*) contained ; moisture 6.21-12.54%, protein 45.93-43.01%, lipid 30.81-27.82%, ash 18.95-16.91% TVB-N value 4.65-20.83 mgN/100g and TVC 1.8×10^3-2.3×10^6 CFU/g while salt and turmeric treated smoke-dried Baim (*M. pancalus*) produced moisture 6.97- 12.53%, protein 59.22-57.17%, lipid 11.67-9.56%, ash 22.54-20.81%, TVB-N value 6.62-20.25mgN/100g and TVC 1.1×10^3-2.0×10^6 CFU/g. It was observed that the TVB-N value have inverse relationship with the sensory score of both smoked-dried products. From the overall performance, salt-turmeric treated smoke-dried Baim has better shelf-life (20 month) than Chapila (14month).

Keywords: Chapila, Baim, physico-chemical quality, Smoke-drying, Salt-turmeric

1. Introduction
Among the good quality animal protein sources, fish is the most perishable. Spoilage set in because fish is susceptible to microbial and enzymatic deterioration and quality reduction occur, if proper steps are not applied to process the fish [1]. The fish loses its organoleptic characteristics and becomes progressively more unacceptable for human consumption. It is a metabolic process that causes food to be undesirable or unacceptable for human consumption due to changes in sensory and nutritional characteristics [2]. The processing and preservation of fresh fish were of utmost importance since fish is highly susceptible to deterioration immediately after harvest and also to prevent economic losses [3]. If fish is not sold fresh, preservation methods should be applied to extend the shelf-life. Some preservation techniques currently used in the tropics include chilling, freezing, drying, salting and smoking. Among them Smoking is one of the traditional fish processing methods aimed at preventing or reducing post harvest losses [4]. Smoking enhances flavour and increase utilization of the fish. Methods of smoking fish vary between different countries and within the same country depending on the species of fish used and the type of product desired [5].

In this experiment we used common fresh water lean fish Chapila (*Gudusia chapra*) and Baim (*Mastacembelus pancalus*) which has unique test.

In Bangladesh smoked fish is recent addition to the fishery products. Fish is normally salted before smoking. Different salting methods are being practiced by the smoked fish industry in different parts of the world [6, 7]. (Espe, 2001; Jittinandana, 2002). But in this research work salt & turmeric used before smoke-drying which are easily available and cheaper cost wise. Salt has been used as a preservative since ancient times, to protect food against bacteria, mold, and spoiling. Basically, salt works by drying food. Table salt or sodium chloride is a common preservative because it is non-toxic, inexpensive, and tastes good. Whereas turmeric is one of the oldest known anti-bacterial ingredients used by the ancient civilizations. In Bangladesh, turmeric is easy available and is considered as one of the important ingredient for cooking any kind of dish. Even in some parts of Bangladesh, rural people usually use turmeric for short time preservation of small sized fishes. But, there is very little scientific information about the use of turmeric in fish preservation.

Due to the consumer awareness of chemical preservatives, extensive studies are being made on natural preservatives for preservation of meat and fish products. The purpose of this study was to extend the shelf life of fish treated with salt and turmeric solution which would not alter the taste and flavor of the food product or add a new undesirable taste. Salt and turmeric were selected because they are often used while cooking fish and easily available in the local market.

Nonetheless, deterioration and spoilage still occur in smoked fish during storage. This study is therefore aimed at assessing the sensory and physicochemical changes in stored smoked

fish. Considerable work has been done on smoked large fish species such as smoked thai-pangus, smoked Ilish, smoked Tilapia in Bangladesh but no serious attempt has yet been made to preserve smoke-dried lean fishes.

2. Materials and Methods

2.1. Sample collection: Two freshwater fish species; Chapila *(Gudusia chapra)* and Baim (*Mastacembelus pancalus*) was collected from the Meghna River early in the morning. Fresh mature fish samples were transported to laboratory in sterile polythene to avoid any type of microbial contamination. This study was conducted between June 2012 to February 2014 at the Fish Technology Section of the Institute of Food Science and Technology (IFST) of Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhanmondi, Dhaka.

2.2. Preparation of Sample: At first, the collected Chapila fish was di-scaled while Baim fish was beheaded. Then both fishes were gutted and washed properly with clean water. The dressed fish samples were then weighed and prepared for further processing.

2.3. Preparation of samples for processing: The dressed fish samples were then dip in freshly prepared 30% salt and 10% turmeric solution for 15 minutes followed by draining.

2.4. Fish smoke-drying: The fishes were smoked in improved traditional type of smoking kiln [8]. The fish smoking kiln was operated by first loading tamarind wood chips and rice-husk into the heat chamber, preheating for some minutes and then loading the fish-samples onto removable wire mesh trays in its central chamber for the smoking process. The desired temperature (75-80^{0}C) was maintained manually. Smoking was done approximately for 4 hours. During the smoking fish samples were turned upside down in the middle period, to make the sample smooth and steady in texture and appearance. The smoked fishes showed characteristic attractive golden brown color and acceptable texture with smoky flavor, which was followed by cooling for 20-30 minutes at ambient temperature to make fish muscle compressed and facilitate to prevent breaking of smoked products. The cooled smoked fish samples were then packed and sealed in vacuum condition with marking taken in two different polythene bags (transparent). Two groups of smoke-dried fish product were then kept for storage at room temperature for further analysis of sensory and biochemical compositions.
During the storage period the two types of smoke-dried fish samples were checked on two month interval basis.

2.5. Physicochemical analysis: Analytical methods were applied for the determination of sensory and biochemical composition of the processed fish products on experimental basis. The analytical methods are given below:

- Physical changes were assessed by the sensory method. Parameters on the questionnaires were as follows: (Like extremely = 9; Like very much = 8; Like moderately = 7; Like slightly = 6; Neither like nor dislike = 5; Dislike slightly = 4 ; Dislike moderately = 3; Dislike very much = 2 ; and Dislike extremely = 1) [9].
- Moisture, fat and ash contents of the fish were determined by AOAC method [10].
- The crude protein of the fish was determined by Micro-Kjeldhal method [11].
- Chemical changes were studied by determining the TVB-N using Conway modified micro-diffusion technique [12].
- Microbiological analysis (TVC) was done according to the Standard method [13].

3. Results

Moisture, protein, fat, ash TVB-N and TVC of fresh Chapila fish was 76.41%, 10.53%, 11.62%, 1.50%, 2.40mgN/100g and 3.1×10^5 CFU/g whereas Baim fish was 77.21%, 15.17%, 6.13 %, 1.72%, 3.16 mgN/100g and 5.8×10^4 CFU/g respectively (Figure 1).

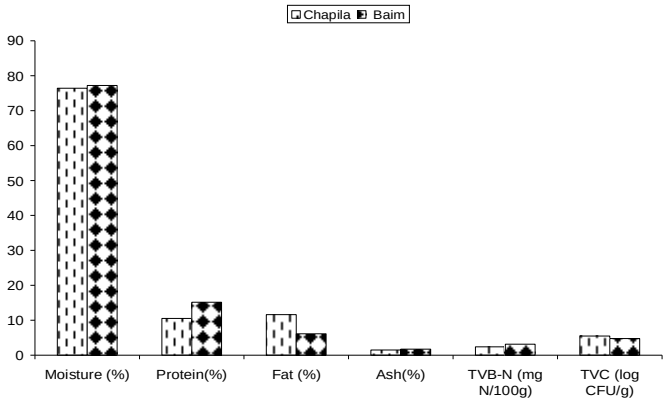

Fig 1: Changes in biochemical composition and TVC of fresh chapila and baim fish.

3.1. Sensory score value: At the beginning of storage all the sensory parameters of these two samples were rated as good based on the grading scale. The highest mean of general acceptability score was found 8.86 in case of S+ T Chapila and 8.87 in S+T Baim smoke-dried fish products. The mean of general acceptability score decreased as storage-duration increased. In this study the shelf-life of salt and turmeric treated smoke-dried Chapila, and Baim fish was 14, and 20 month. The mean of general acceptability score of the end product of smoke-dried Chapila and Baim was 3.62(14 month) and 4.43 (20 month) respectively. Sensory score value decrease with the increase of TVB-N value and storage period (Figure 2, 3).

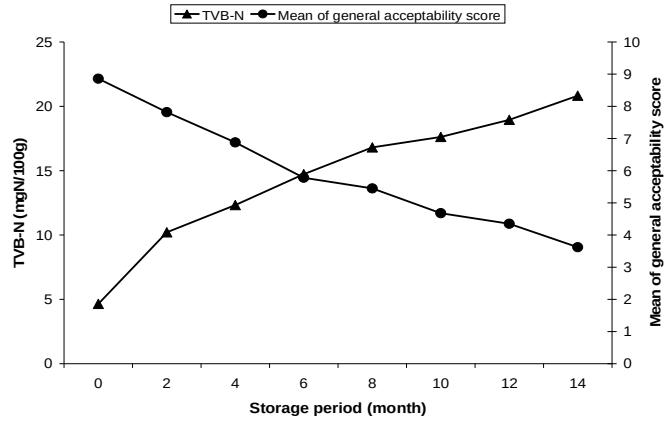

Fig 2: Changes in TVB-N value and mean of general acceptability score of salt and turmeric (S+T) treated smoke-dried Chapila fish during storage at room temperature (26-31 0C).

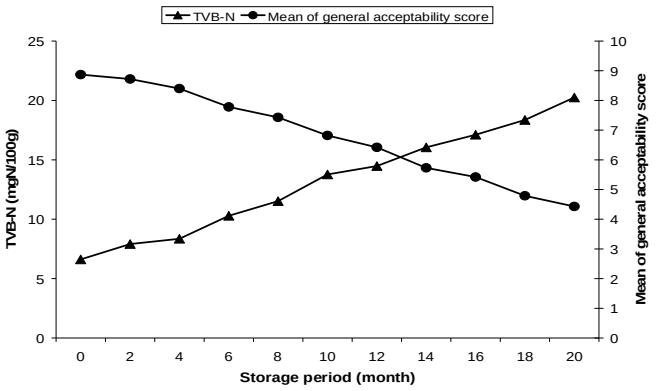

Fig. 3 Changes in TVB-N value and mean of general acceptability score of salt and turmeric (S+T) treated smoke-dried Baim fish during storage at room temperature (26-31 ^{0}C).

3.2. Biochemical analysis: In the present study the values obtained from the analysis of biochemical composition which includes proximate composition such as moisture, protein, fat, ash and chemical composition such as TVB-N value have been described below-

3.2.1. Proximate composition: During storage at room temperature, percent of moisture were found to vary from 6.21 % (o day) to 12.54% (14 month) for salt-turmeric treated Smoke-dried Chapila, and 6.97% (o day) to 12.53% (20 month) for salt-turmeric treated smoke-dried Baim fish respectively.
Protein (%) were found to vary from 45.93 % (o day) to 43.01 % (14 month) for salt-turmeric treated smoke-dried Chapila, and 59.22 % (o day) to 57.17 % (20 month) for salt-turmeric treated smoke-dried Baim respectively.
Fat (%) were found to vary from 30.81 % (o day) to 27.82 % (14 month) for salt-turmeric treated smoke-dried Chapila and 11.67 % (o day) to 9.56 % (20 month) for salt-turmeric treated smoke-dried Baim respectively.
Ash (%) was found to vary from 18.95 % (o day) to 16.91 % (14 month) for salt-turmeric treated smoke-dried Chapila and 22.54 % (o day) to 20.81% (20 month) for salt-turmeric treated smoke-dried Baim respectively (Figure- 4, 5).

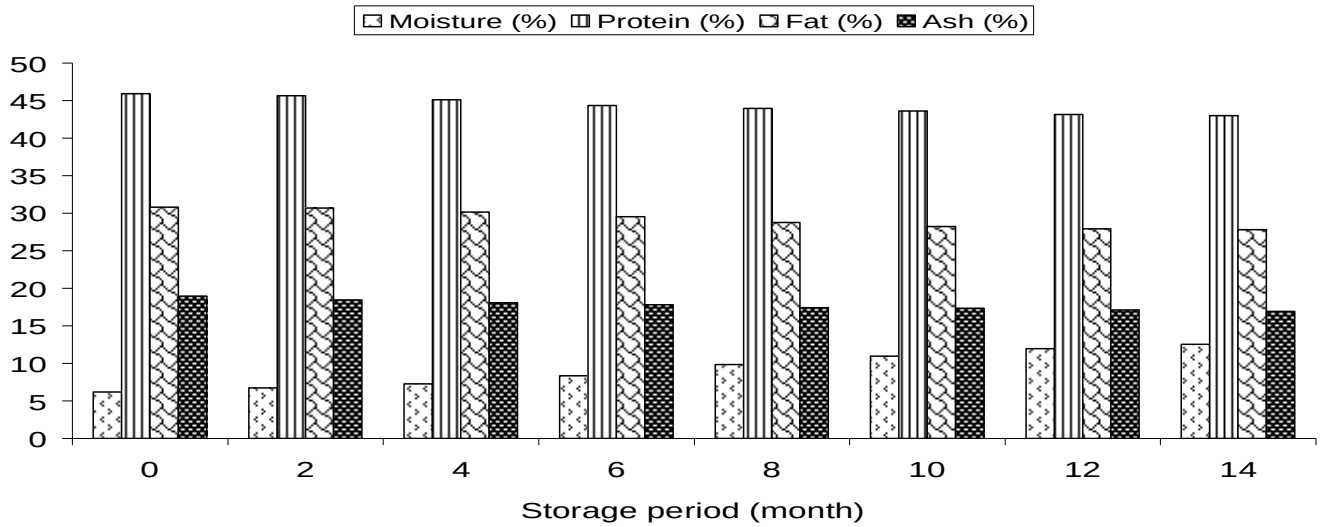

Fig. 4 Changes in proximate composition of salt and turmeric (S+T) treated smoke-dried Chapila fish during storage at room temperature (26-31^{0}C).

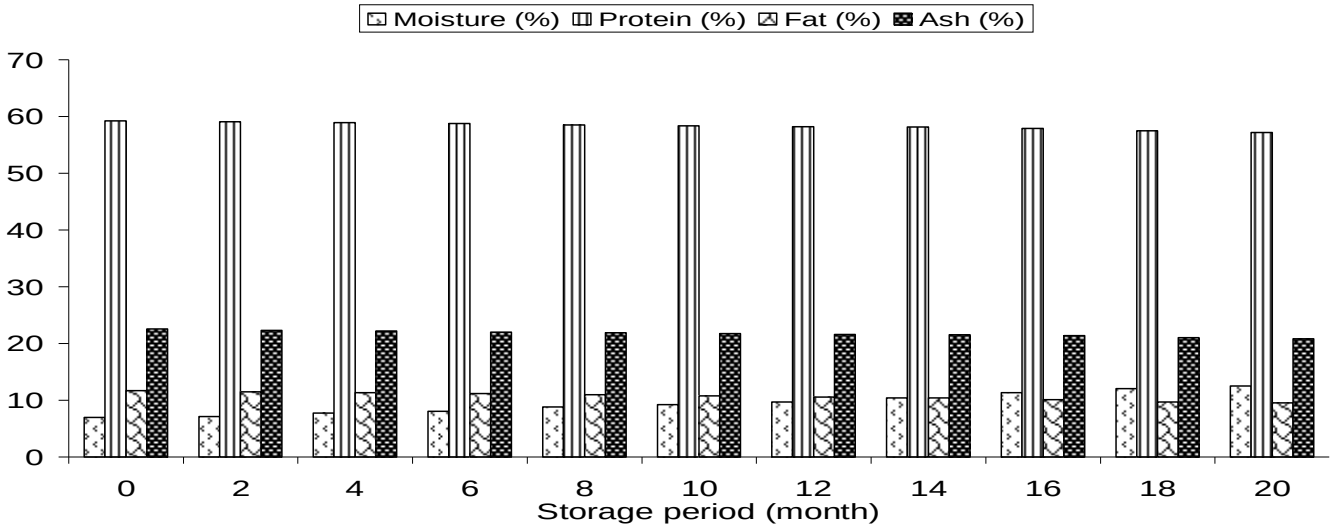

Fig. 5 Changes in proximate composition of salt and turmeric (S+T) treated smoke-dried Baim fish during storage at room temperature (26-31 ^{0}C).

3.2.2. Chemical composition (TVB-N Value): In salt-turmeric treated smoke-dried Chapila fish product, the TVB-N values ranges from 4.65 (0 day) to 20.83 mgN/100g (14 month) whereas ranges of TVB-N value was 6.62 (0 day) to 20.25 mgN/100g (20 month) mgN/100g in salt-turmeric treated smoke-dried Baim fish product respectively.

3.3. Microbiological analysis: In view of present study, Total Viable Counts (TVC) of salt and turmeric treated smoke- dried chapila and Baim fish samples ranged from 1.8×10^3 (0 day) to 2.3×10^6 CFU/g (14 month) and 1.1×10^3 (0 day) to 2.0×10^6 CFU/g (20 month) respectively (Figure-6).

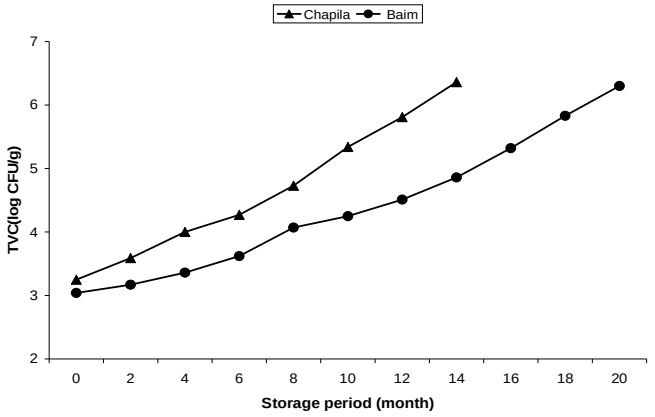

Fig. 6 Changes in Total Viable Count (TVC) log CFU/g of salt and turmeric (S+T) Treated smoke-dried Chapila and Baim fish during storage at room temperature (26-31^{0}C).

4. Discussion

In Bangladesh among the freshwater small fish species, Chapila and Baim fishes are very delicious, high market prize, nutritious and popular to the consumers. So these fishes are very important due to commercial purpose. Fresh sample presented low protein content [14].

4.1. Sensory score value: Sensory methods are considered to be the most useful and dependable criteria for assessing the degree of freshness for quality determination. Human being is capable to detect defects from visual signs of deterioration such as loss of freshness and changes during storage period. Sensory quality assessment is an easy, quick and efficient method of getting idea about the quality of the product. This method is based on the response or tendency of sense organ for accepting the food products.

The quality assessment as well as sensory evaluation (score) was carried out every three months intervals for samples stored at room temperature (26-31^{0}C) using trained panel of four judges following 9-point ascending scale to evaluate changes in color, odor, texture, general appearance and mean of general acceptability until it was an acceptable condition [15].

Sensory characters (color, texture, flavor, general appearance) of these two types of salt and turmeric treated smoke-dried fish samples showed that apart from the preservative effect of turmeric, it also acted as a flavoring substances. The aroma from all these two salt and turmeric treated smoke-dried fish samples were characteristically desirable.

The shelf-life of these two types of smoke-dried fish product was found to be related to the temperature and the length of storage. This agrees with the results of research into storage of smoke dried fish and crustaceans (Oyster and shrimps) which revealed quality loss during storage both at ambient temperature and chilling [16]. Because of antifungal effect of turmeric, there is no fungal attack shown on salt-turmeric treated smoke-dried Chapila and Baim fish product.

4.2. Biochemical analysis:

4.2.1. Proximate composition: During smoke-drying, the percentage of moisture content decreased and protein, fat and ash content increased significantly. Doe and Olley (1983) reported that smoking resulted in the concentration of nutrients due to low residual moisture level [17]. This observation is in agreement with the findings of Atlantic mackerel and European eel, pike perch and rainbow trout [18].

The moisture content can be used as a pointer to the rate at which deterioration occurred in fish samples resulting in the early decomposition. There was a gradual increase in the moisture content of this two types of salt- turmeric treated smoke-dried fish samples with increasing storage period. The gutted smoke dried fish samples of African cat fish (*Clarias nigrodigitus*) had moisture content as 6.27 to 10.92 % which is similar with present study (Faturoti, 1985)[19]. Moisture content of 12% is the level beyond which fish products begin to grow moulds after few days [20]. In this study the final moisture of salt-turmeric treated smoke-dried fish samples was less than 12%. Significant increased in protein levels in two types of smoke-dried fishes when compared with the fresh fish, suggested that protein nitrogen was not lost during smoke-drying [21]. Protein decomposes with passing time [22]. In storage condition, the protein content decreased significantly with the time due to water soluble protein diffused out to the surrounding for exosmosis [23]. This could be due to gradual degradation of initial crude protein to more volatile products such as total volatile bases, hydrogen sulphide and ammonia [24]. Similar drop in protein concentration was reported for *Heterobranchus longifilis* [25].

Usually moisture and fat contents in fish flesh are inversely related and there sum is approximately 80% [26]. This inverse relationship was also well defined in this experiment. The ash content change with the time of storage due to absorbance of moisture and loss of protein [23]. Smaller sized fish species has higher ash content due to the higher bone of flesh ratio [16].

4.2.2. Chemical composition(TVB-N value): It was observed that spoilage of fish flesh resulted from the action of enzymes and bacteria; this can be slowed down through the application of salt and removal of moisture to increase the shelf life of fish. Total Volatile base Nitrogen (TVB-N) is widely used as an indicator of the degree of lipid oxidation [27]. It helps to measure the level of fish spoilage and to explore the shelf life of fish. During storage period total volatile base nitrogen value (TVB-N) increased. Pearson recommended that the limit of acceptability of fish is 20-30mg N per 100g [28]. While Kirk and Sawyer suggested a value of 30-40mg N/100g as the upper limits [29]. Increase in final values of TVB-N in this study is similar with other researchers [25, 30]. During hot smoking fish are exposed to heat and atmospheric oxygen. These factors can accelerate the oxidation of the fish lipids resulting in an increased in TBA [31].

4.3. Microbiological analysis: Total Viable Counts (TVC) of smoke-dried chapila and baim fish samples were increased with increase in the duration of storage due to growth and multiplication of the microbes [31]. As the duration of storage increased processed fish samples may absorb small amounts of moisture from surrounding atmosphere providing enabling environment for microbial growth [32]. Smoking inhibits microbial growth in stored fish products [33]. It is generally accepted that fish with microbial load $>10^6$cfu/g is likely to be at the stage of being unacceptable from the microbiological point of view and unit for consumption which agrees with the present research work [34].

5. Conclusions

This research showed basic nutritional information on freshwater small fishes; Chapila and Baim both fresh and smoke-dried condition. It also provides a possible application of smoke-drying as an efficient drying for fish preservation. Presence of salt and turmeric mixture gave better smoke-dried fish products in terms of biochemical and sensory parameters. During storage at room temperature, after 14 month it was found that the salt-turmeric treated smoke-dried Chapila fish product was spoiled while the salt-turmeric treated Smoke-dried Baim fish was found to be in normal characteristics up to 20 months.

It proved that fish smoke-drying using salt and turmeric mixture often dry faster, keep on good nutritional qualities, lower final moisture content, prolonged their shelf life and is hygienic which enhance the value in local as well as export market.

6. Acknowledgments

The author acknowledges the scientist and technicians of BCSIR, Dhaka, Bangladesh for their technical help.

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